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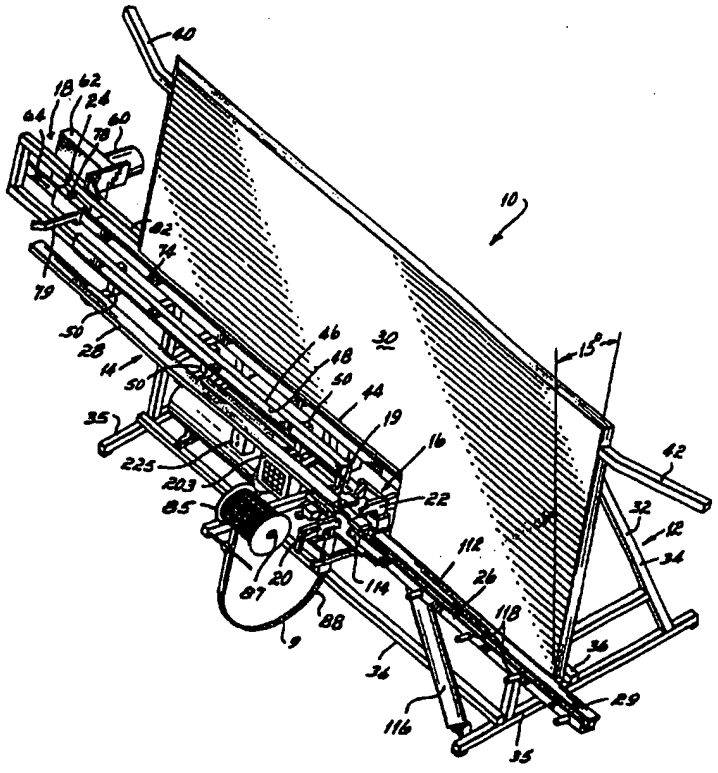
(54) Title: MACHINE AND METHOD FOR APPLYING BORDER CLIPS

(57) Abstract

A machine (10, 10') and method for securing border rods (6) on mattress spring assemblies (5) is disclosed. The machine (10, 10') comprises a support (14) for supporting a spring assembly (5) having border rods (6) preclipped at the corners on opposite sides thereof, a drive system (18) for continuously advancing one edge of the spring assembly (5) and the border rods (6) through a clip application station (16), two clip actuation gems (20, 22), a mechanism (26) for rotating the spring assembly (5) through 90° after application of clips (19) to secure the border rods (6) to one edge of the spring assembly (5), and a control system that detects the entrance of springs (8) of assembly (5) into the clip application station (16) and then actuates the two clip application gems (20, 22) in sequence such that the springs (8) are successively secured to the border rods (6) along the one edge of the spring assembly (5) during passage thereof through the clip application station (16).



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MACHINE AND METHOD FOR APPLYING BORDER CLIPS

This application is a continuation-in-part of the commonly assigned and copending U.S. patent application serial no. 08/653,612 filed May 24, 1996.

Background of the Invention

This invention relates to machines for applying border rods to bedding spring assemblies.

Bedding mattresses generally have border rods surrounding and attached to the top and bottom surfaces of a spring assembly. It is now a common practice to secure such border rods to the mattress spring assembly by means of sheet metal clips. Machines such as those disclosed, for example, in U.S. Patent Nos. 4,724,590; 4,815,182; 4,829,643; and, 4,907,327, have been developed for attaching the border rods to the mattress spring assemblies with a minimum of manual labor.

The machines illustrated and described in the first two of the above-identified patents, are so-called horizontal clip application machines wherein a bedding spring assembly and top and bottom border rods are maintained in a horizontal attitude while the spring assembly and border rods are moved as a sub-assembly and indexed past two opposed clip application stations. At each clip application station, a pair of clip application guns are operative to apply clips to the sub-assembly. In the machines disclosed in these two patents, sensors detect the presence of springs in the clip application stations, stop the indexing movement of the sub-assembly, and cause the guns to fire so as to cut endmost clips from rows of connected strips of clips and wrap those endmost cut or severed clips about the border rods and adjacent springs. This indexing and clipping process is repeated until clips are applied to the full length of opposite sides of the spring assembly. After the border rods have been clipped to two opposite sides of the spring assembly, the spring assembly and border rods are rotated 90° and then moved through a second machine to complete the application of the clips to the remaining two sides of the spring assembly.

The horizontal machines disclosed in these two patents were never commercially successful for a number of reasons, including particularly, the inability to properly position the springs relative to the border rods for simultaneous application of the sheet metal clips to opposite sides of the spring assembly, as well as the complexity and size of the machines.

The machines disclosed in the last two of the four above-identified patents are referred to as vertical clip machines in which the spring assemblies having the border rods pre-clipped thereto at the corners are supported in a vertical attitude on a bottom supporting plate and are indexed past a pair of clip application guns. These guns are located at a clip application station adjacent the bottom edge of the spring assembly. As the spring assembly and border rods move on edge past the guns, the assembly is stopped and the guns are actuated or fired to sever the endmost clips from a pair of strips of metal wire connected clips and to wrap the severed endmost clips about the border rods and edgemost springs. After the spring assemblies and border rods are clipped on one complete side, the machine is operative to rotate the assembly 90° and repeat the indexing movement of the spring assembly past the guns to clip the second, third and fourth sides of the spring assembly to the border rods.

The vertical clip application machines identified in the latter two of the four above-identified patents have been used commercially, but those machines have numerous shortcomings. Among those shortcomings is the problem of stopping the movement of the spring assembly and properly positioning the individual springs at the clip application station such that when the guns fire, the clips wrap about the border rod and adjacent spring without missing either the spring or the border rod, or both. Because of improper positioning, clips often miss the target and create voids on the spring assembly where there is no clip, but where there should be one. In that event, the end of the unclipped spring is free to move relative to the border rod. Before the spring assembly may be upholstered, this missed clip condition must be manually corrected via a hand-held gun operated by a machine operator who corrects the errors by manually applying missing clips at the missed clip sites.

Another shortcoming or problem characteristic of the vertical clip machines described in the above-identified patents is also attributable to the repeated stopping and starting of the spring assembly each time the spring assembly and border rods are indexed relative to the clip application guns. This repeated start up and stopping of the indexing movement causes substantial wear on the parts of the machine. It also results in inertial errors as a consequence of the spring assembly overrunning or underrunning the clip application station. If upon stoppage of the spring assembly, the inertia of the complete assembly and mechanism for moving the assembly causes the spring assembly to overrun or underrun the clip application station, clips will not be applied to the springs, but will miss the spring although they may wrap about the border rod, but without catching and entrapping a spring therein. To minimize this problem, clutches and brakes are applied to the drive mechanism in an attempt to compensate for this inertial error.

Yet another shortcoming or problem characteristic of the vertical clip machines described in the above-identified patents occurs as a consequence or inability of the machine to detect the presence of a spring at the clip application station. In the first three of the above-identified patents, optical sensors were utilized, but those optical sensors in many cases missed or failed to detect the presence of a spring at the clip application station. In an attempt to overcome that problem, the last of the above-identified patents utilized mechanical sensors which were positioned so as to contact the springs as they moved into the clip application station. The sensors described in this patent are electrically conductive sensors which detect and close a control circuit upon presence of the spring at the clip application station. Closing of this circuit in turn actuates a clutch and brake to stop the spring assembly and border rods at the clip application station. But

these sensors require constant repositioning with each change of size or configuration of spring, a very time-consuming and difficult problem. Additionally, these mechanical sensors are subject to moving out of adjustment such that constant readjustment is required to minimize missed clips on the spring assembly.

Another shortcoming or problem encountered with the vertical clip machines described in the above-identified patents occurs as a consequence of the on-edge spring assembly travelling and being supported upon flat metal plates over which the bottom edgemost springs and border rods move. The spring assemblies are supported with the end turns of each edgemost coil spring resting upon these flat metal plates. There is a tendency for corner clips, or so-called pre-clips, applied when the corners of the border rods are pre-clipped onto the spring assembly, to catch and dig into these supporting plates, causing the unit to snag or hang up on the plates, with resulting damage to the spring assemblies and/or the machine.

Other shortcomings or problems encountered with these vertical clip machines described in the last two of the four above-identified patents are primarily attributable to the controls and the sequence of operations affected by these machines. Among those problems are excessive noise created by simultaneous actuation of numerous air cylinders and mechanical controls of the machine, frequent and difficult readjustments required to accommodate differing size and coil count units, and difficult to adjust components which are easily moved out of adjustment.

Another prior art patent which discloses a machine for attaching border rods to spring assemblies is disclosed in European Patent No. 0549513A1. The machine described in this patent is also an indexable vertical machine and is operative to clip border rods to spring assemblies, but this machine forms the clips simultaneously with the application of the clips to the spring assemblies. For most applications, the forming of the clip, as well as the application of it to the spring assembly and border rods at each clip application station, is financially impractical because of the excessive cost of a machine capable of both forming the clip from sheet metal (as opposed to applying preformed clips), and applying the clips to the border rods and spring assembly. Additionally, this machine also has the indexable starting and stopping problems described hereinabove relative to the earlier described prior art machines.

Summary of the Invention

The invention of this application which overcomes or substantially reduces the problems encountered by the prior art machines described hereinabove comprises a supporting framework for supporting mattress spring assemblies having border rods pre-clipped thereto at the corners. This supporting framework supports the spring assembly in a position angled slightly at the top away from vertical or at the rear slightly upwardly away from horizontal. In either event, the bottom edge to be clipped rests upon and is supported from a monorail which supports the spring assembly from the center portion, rather than the end portions, of the bottommost springs. The bottom edge of the spring assembly is moved continuously into and through a clip application station whereat the presence of a bottom edgemost spring is optically detected and a pair of clip application guns actuated in sequence to apply clips to opposite ends of the spring. An encoder is attached to the drive shaft of the machine which affects movement of the spring assembly relative to the clip application stations such that programs covering differing configurations of spring assemblies having differing coil spring counts enable the operator to select, via a control monitor, the size and configuration of the unit and coil count of the unit to be processed in the machine. This encoder, in combination with

fixed position sensors which seldom, if ever, need adjustment and which cannot be knocked out of alignment, enable the machine to be quickly set up and operated to apply border rods to multiple different configuration and sizes of spring assemblies.

The primary advantage of the invention of this application resides in its elimination of the stop and start indexing movement of the spring assembly and border rods relative to the clip-wrapping station and the guns located at that station. Instead of stopping and starting the movement of the spring assembly and border rods relative to the gun each time that a pair of clips are applied to one side of the spring assembly, the machine of this application is operative to effect the application of the clips to the assembly while the spring assembly moves continuously past those guns without any stopping and starting of the assembly. Thereby, the cost of the machine, as well as substantial wear and tear of the machines, is reduced.

Another advantage of this machine is attributable to the monorail system upon which the spring assembly is supported during movement relative to the clip-wrapping station and clip-wrapping guns located at that station. This monorail system supports the springs from the center portions of the springs rather than from the larger diameter end turns. Thereby, hang ups of the spring assembly relative to the supporting structure are minimized or eliminated, and wear and tear of the supporting structure is substantially reduced. Furthermore, this supporting arrangement enables the fiber optic sensor to more accurately and easily sense the presence of a spring at the clip-wrapping station because of the reduction in variance of coil diameters at the center of the spring assembly relative to that of the end turns of the springs within an assembly.

Yet another advantage of the machine of this invention is attributable to the improved controls which eliminate the need for physical adjustment of sensors upon every change of size of spring assembly or coil count within an assembly, as has been required in the prior art machines.

These and other objects and advantages of this invention will become more readily apparent from the following description of the drawings, in which:

Brief Description of the Drawings

Fig. 1 is a perspective view of a border rod clip application machine incorporating the invention of this application;

Fig. 2 is a end elevational view thereof;

Fig. 3 is a front elevational view thereof taken on line 3-3 of Fig. 2;

Fig. 4 is an enlarged perspective view of the clip-wrapping station of the machine of Fig. 1;

Fig. 4A is an enlarged perspective view of the portion of Fig. 4 encircled by the phantom line 4A;

Fig. 5 is a top plan view of the clip-wrapping station of the machine of Fig. 1;

Fig. 6 is a cross sectional view taken along line 6-6 of Fig. 5;

Fig. 7 is a cross sectional view taken on line 7-7 of Fig. 5;

Fig. 8 is a cross sectional view taken on line 8-8 of Fig. 3;

Fig. 9 is a perspective view of a second embodiment of clip application machines incorporating the invention of this application.

Fig. 10 is a schematic diagram the interconnection of the controls of the machine incorporating the invention of the present application with moveable components thereof.

Fig. 11 is a flowchart illustrating a production cycle thereof.

Figs. 12, 12A, 12B and 12C are block diagrams illustrating screens of the operator control interface thereof.

Detailed Description of the Invention

The clip application machine 10 of this invention comprises a supporting framework 12 which includes a spring assembly support 14. This spring assembly support 14 maintains a spring assembly 5 in an upright on-edge attitude in the course of its movement through the machine 10. In the course of movement through the machine 10, pre-formed and generally U-shaped sheet metal clips 9 (Fig. 4A) are applied and wrapped about border rods 6 and springs 8 as the border rod and springs pass through a clip application station 16. To effect this movement of the spring assembly 5 over the support 14 and through the clip application station 16, there is a drive mechanism 18 associated with the support includes a pusher or pusher assembly 24 operative to contact the rear edge of the assembly 5 and push the spring assembly over the support at a controlled speed and feed rate. As the individual bottom edgemost springs of the spring assembly enter into the clip application station 16, their presence is detected by an optical sensor 19 which, through an appropriate control circuit, then triggers sequential actuation of a pair of longitudinally offset clip application guns 20, 22 at the clip-wrapping station 16. In contrast to prior art clip application machines, the machine of this invention applies the clips on the fly while the spring assembly continues to move at a fixed rate through the clip application station. After clips 9 have been applied to one complete side of the spring assembly 5, forward movement of the pusher 24 and the spring assembly is stopped, the pusher 24 is moved rearwardly, and the complete spring assembly 5 rotated 90° by a rotating mechanism 26. After rotation of the spring assembly 5 through the full 90°, the spring assembly 5 again rests upon the spring assembly support 14, at which time the pusher assembly 24 again moves into contact with the rear edge of the spring assembly 5. The pusher assembly 24 then proceeds to push the second side of the spring assembly 5 through the clip application station 16 whereat clips 9 are applied to springs 8 and border rods 6 along the complete second side of the spring assembly. This process is then repeated for the third and fourth sides of the spring assembly 5, after which the spring assembly 5 is physically removed from the clip machine 10 preparatory to reception of a new spring assembly 5 onto the machine 10.

Spring Assembly

The spring assembly 5 to which sheet metal clips are applied in accordance with the practice of this invention comprises a plurality or matrix of springs 8 arranged in rows and columns and interconnected, as for example, by conventional helical lacing wires. These springs 8 may be conventional knotted or unknotted springs, individual cylindrical springs, or multiple springs or so-called continuous springs in which a complete row of springs is formed from a single length of wire. The configuration of the springs is of no significance to the practice of this invention. To this array or matrix of springs, a first border rod 6 is applied and surrounds one side of the matrix, and a second border rod 7 surrounds and is attached to the opposite side. According to the practice of this invention, these border rods are pre-clipped by clips 9 at the corners to the spring matrix to form a spring assembly preparatory to being inserted into the machine 10. This pre-clipping of the springs may involve only pre-clipping of the cornermost springs or pre-clipping of three springs, one on each side of the cornermost spring at each corner of the spring matrix.

Machine Framework and Spring Assembly Support

In the course of movement through the machine 10, the spring assembly 5 is supported from a bottom monorail 28 and a rear supporting plate 30. The rear supporting plate 30 is angled or tilted at an angle of approximately 15° from the vertical plane such that the top edge of the plate 30 is spaced rearwardly from the lower edge by the 15° angle. These supporting elements, the monorail 28 and rear support plate 30, are in turn supported from a generally A-shaped frame 32. This frame 32 comprises a pair of A-shaped end braces 34 mounted atop transversely extending end rails 35 and interconnected by longitudinally extending connector bars 36.

With reference to Fig. 1, it will be seen that the rear supporting plate 30 is generally rectangular in configuration with outrigger wings 40, 42 extending outwardly and rearwardly from the input and output ends of the plate 30 adjacent the top edge thereof. These wings 40, 42 facilitate placement of the spring assemblies 5 onto the machine and removal therefrom, which placement is usually done manually by operators simply grasping the spring assembly and moving onto or off of the machine.

Adjacent the lower edge of the rear support plate 30, there is a rectangular cut-out 44 on the lower edge thereof. This cut-out 44 facilitates access to the bottom and rear sides of the spring assembly 5 as the spring assembly 5 moves over the rear supporting plate 30 and monorail 28. Within this recess, there is a rear guide bar 46 supported from the framework 12. This bar 46 has a front face 48 located in a common plane with the front face of the rear support plate 30 such that it assists in guiding the spring assembly in its movement over the monorail 28 and rear supporting plate 30. The monorail 28 is in turn supported from this guide bar 46 by generally L-shaped braces 50, the lower legs of which are fixedly secured to the underside of the monorail 28.

With reference now to Fig. 4, it will be seen that the monorail 28 is generally shaped as an inverted U-shaped channel 52. Contained within this channel 52 is a supporting bar 54, the end portion of which extends into and through the clip application station 16 beyond the terminus 56 of the channel 52. Within the clip application station 16, the end portion of the supporting bar 54 has a longitudinally extending groove 58 from the opposite sides of which are machined recesses 59 which facilitate access of the clip guns 20 and 22 to the springs 8 of the spring assembly 5 as the springs 8 pass through the clip application station 16.

Drive Mechanism

The drive mechanism 18 for advancing a spring assembly 5 continuously into and through the clip application station 16 is best illustrated in Figs. 1 and 3. This drive mechanism 18 comprises a drive motor 60 operative to drive via a transmission 62, an output drive shaft 64, all of which are mounted upon and supported from the framework 12 of the machine. The transmission 62 may be a direct belt and sprocket drive, or a gear drive, or some other drive linkage that transmits power from the motor 60 to the shaft 64 at an appropriate speed ratio.

The output shaft 64 of the transmission 62 is operative to drive a sprocket 66 of an endless chain drive 68, which includes an idler sprocket 70. The chain drive 68 includes an endless chain 72 movable between the drive sprocket 66 and the idler sprocket 70. This chain drive runs in parallel with a framework supported horizontal guide rail 74 over which the pusher 24 is movable. The pusher 24 is fixedly attached to one run of the chain drive, such that as the pusher moves over the guide rail 74 and between the sprockets

66, 70, it causes the pusher to move lengthwise of the machine. In the course of moving lengthwise of the machine, a forwardly extending arm or pusher plate 79 mounted upon the pusher 24 engages the trailing side of the spring assembly 5 and causes that spring assembly 5 to move with the pusher 24 forwardly over the monorail 28. The pusher 24 may include a spring bias (not shown) on the arm 79 and a safety switch (not shown) operable in the event of a jamb of the spring assembly on the machine to cause the arm 79 to move rearwardly on the pusher 24, trip the switch, and turn off the machine until the jamb is corrected.

Also mounted on the pusher 24 is an actuating pin 78 cooperable with a sensor 80 mounted on a rail 82 of the framework 12 to initially position the pusher 24 on the guide rail 74. When the actuating pin 78 is positioned immediately adjacent to the sensor 80, the pusher is zeroed relative to an encoder 84 which is driven from the drive shaft 64 of the drive mechanism. As the drive shaft 64 is rotated, it causes the encoder to rotate and feed a position signal to the control system of the machine 10, all as explained more fully hereinafter in connection with the description of the operation of the machine 10.

Clip Application Station

With reference to Figs. 1 and 4 through 7, it will be seen that there are two clip application guns 20, 22 located at the clip application station 16. These guns 20,22 are longitudinally offset one from the other as may best be seen in Fig. 5, such that the guns fire sequentially rather than simultaneously to apply a pair of clips to a single spring as that spring passes through the clip application station 16. These guns are adjustably mounted upon the framework 12, but once adjusted, are intended to remain in a fixed position on the frame, such that no further adjustment will be needed even when the machine is converted from one size spring assembly to another or from one coil count of springs in an assembly to another coil count.

The clip guns 20, 22 are conventional clipping guns operative to clip a conventional three-pronged clip 9 onto the border rod and spring of a spring assembly 5. One such gun suitable for use in this application is that disclosed in U.S. Patent No. 4,546,528. Other guns suitable for use in the machine 10 are disclosed in the patents identified in the preamble of this application. These guns 20,22 each comprise a gun body having a pneumatic actuator operable to move a reciprocable blade and forming die relative to a stationary anvil so as to sever an endmost clip 9 from a roll of clips and wrap a single clip about a border wire and spring capture between the forming die and anvil of the gun.

A typical three-prong clip 9 utilized in the practice of this invention is illustrated in Fig. 4A. This clip 9 is supplied to the clip application guns 20, 22 from a pair of rolls 85, 86 of collated clips. Both rolls 85, 86 are rotatably supported upon the frame of the machine from a supporting arm and shaft 87. The roll 85 for the front gun 20 may be mounted at the front of the machine 10 and the roll 86 for the back gun 22 may be mounted at the back of the machine 10, as illustrated in Figs. 1 and 2. Alternatively and preferably, the roll 85 for the front gun 20 is also mounted to the back of the machine 10, as illustrated in phantom at 85a in Fig. 2.

A preferred form of clip 9 utilized in the practice of this invention is illustrated and describe in U.S. Patent Nos. 5,303,821 and 5,314,065. In accordance with the practice of this invention, these clips 9 are stored in rolls and are fed from the rolls through an arcuate guide 88, 90 from the rolls 85, 86, respectively, to the pneumatically actuated guns 20, 22. These guns then are operative to apply the clips to the border rods and springs by severing the connecting plastic ropes which interconnect the clips and causing the clips

to close about the border rods and springs. These guns also automatically feed and cause the clips to be pulled from the rolls into the gun.

In order to ensure that the machines stop feeding or moving spring assemblies 5 through the machine in the event that a roll of clips runs out of clips, there is a clip detection sensor 99 present at the discharge end of each gun 20, 22. This sensor 99 comprises an optical sensor 99 illustrated in Fig. 4A. So long as there is a clip present in the gun, a light beam 100 transmitted by a source (not shown) and exiting through tube 96 will detect the presence of that clip and allow the machine 10 to continue to operate. In the event that that light beam, though, is not broken by the clip, indicating the absence of a clip 9 at the gun, the sensor 99 will detect that condition and discontinue the feed of the spring assembly 5 through the clip application station 16.

In order to control the timing of the clip application guns 20, 22, there is an optical sensor 19 located immediately upstream of the guns 20, 22. This optical sensor 19 is contained within the supporting bar 54 and is operative to direct a light beam upwardly through the center portion of the spring 8, as opposed to the end turns of the springs. In operation, this sensor 19 triggers a signal via the encoder 84 associated with the drive shaft 64 of the pusher 24 to cause the guns 20, 22 to be fired after a preset number of pulses from the encoder 84 as explained more fully hereinafter in connection with the description of the operation of the machine 10 and the machine control circuit.

In lieu of a single sensor 19 operable to sense the arrival of a spring 8 at the clip application station 16 and via a signal from the encoder 84 sequentially actuate the two guns 20, 22 at the appropriate time to sequentially apply clips to opposite ends of the spring as the spring passes the guns 20, 22, two sensors 19a, 19b may be utilized, one for each gun 20, 22, respectively. In that event, the optical sensor 19a would sense the arrival of a spring at the clip application station 16, and after a predetermined number of pulses from the encoder 84, trigger the gun 20, and the sensor 19b would do the same thing for the gun 22, again, operating the guns sequentially, such that they never fire at the same time. Preferably, the sensor 19a would be spaced at about the same distance upstream of the gun 20 as the sensor 19b is spaced upstream of the gun 22, with both sensors 19a,19b being as close to the respective guns 20,22 as practical. The guns 20,22 could be then spaced farther apart without being so far from the sensors 19a,19b as to increase the risk of error in the timing of the triggering of the guns 20,22. Thereby, noise problems associated with the firing of the guns 20,22 in application of the clips 9 is minimized.

It is critical to the application of border rods to mattress spring assemblies that the border rods be positioned and clipped to the outside of the end turns of the springs, as best illustrated in Fig. 4. If the springs inadvertently become clipped to the outside of the border rods, the resulting spring assembly is difficult to upholster, and when upholstered, may be unsightly. To ensure that the border rods are always positioned on the outside of the spring assemblies, the machine of this invention incorporates a pair of border rod movable spreader pins 104, 106, each mounted on the end of the rod of a double acting pneumatic pin lift cylinder 104a,106a, respectively, each mounted on one of a pair of guided plates 105, which normally reside in an extended position adjacent to the monorail supporting bar 54, in which position the cylinders 104a,106a are normally retracted with the pins 104,106 thereby normally lowered. In this position of the spreader pins 104,106, the pre-clipped cornermost springs may move past the spreader pins 104, 106

without any interference thereberween. After the pre-clipped corner springs have moved downstream of the spreader pins 104,106, the pins are raised by extension of the cylinders 104a,106a and then moved outwardly away from the monorail supporting bar 54, and in the course of moving outwardly, pull the border rods 6 and 7 outwardly away from the end turns of the springs 8. Thereby, the border rods are maintained in a position spaced outwardly away from the end turns of the springs until the border rods enter between the movable dies and anvils of the clip guns whereat the border rods are forced into juxtaposition with the end turns of the springs, but remain outboard of the springs. After the last spring to be clipped has passed the spreader pins, those pins 104,106 are lowered by retraction of the rods of the cylinders 104a,106a and again moved inwardly in juxtaposition to the supporting bars so as to permit the pre-clipped trailing corners of the spring assembly to move over and past the border rod spreader pins 104, 106.

To effect this outward and inward movement of the spreader pins 104, 106 toward and away from the supporting bar 54, there are a pair of double acting air cylinders 108, 110 associated with the spreader pins 104, 106, respectively. These air cylinders 108,110 are each operative, along with the cylinders 104a,106a, through a common control valve 109. The movement of the cylinders 108,110 effects reciprocal movement of guided plates 105 and attached guide rods 107 so as to cause the plates 105 and attached spreader pins 104, 106 and their cylinders 104a,106a to move toward and away from the monorail supporting bar 54. These control valve 109 is a spring-biased single acting valve which actuates all four of the double acting cylinders 104a,106a and 108,110 to spread the border wires when a signal is applied, then positively reverses these cylinders when a signal is removed to allow the spreader pins 104,106 to retract rapidly. Air to the cylinders 108,110 is metered by devices (not shown) to insure that the cylinders 104a,106a raise the pins 104,106 before the cylinders 108,110 move the guided plates 105 and the pins 104,106 outwardly. While the cylinders are double acting, the border wires are not driven by the pins as they move inwardly to an extended position and are only engaged by the pins when the cylinders 108,110 are caused by air actuation to move the plates outwardly, thereby pulling the border rods away from an outboard of the end turns of the springs.

Rotation Mechanism

After all of the springs on one side of the spring assembly 5 have moved through the clip application station 16, the pusher assembly 24 continues to push the spring assembly forwardly on the monorail 28 until the trailing edge of the assembly has passed through the clip application station and onto a monorail 29 of a spring assembly rotating assembly 26. The monorail 29 is generally channel-shaped, as best illustrated in Fig. 8. The top surface 112 of the monorail 29 is located in a common horizontal plane with the top surface of the monorail 28 and monorail supporting bar 54, such that it, in effect, forms a continuation of the monorail 28.

As best illustrated in Figs. 1 and 8, the monorail 29 is a generally rectangular tube supported from frame 12. Bolted to the base of the tube of the monorail 29 is a generally L-shaped channel 113. The assembly of the monorail 29 with the channel 113 bolted thereto have the upstream end thereof pivotally connected to the framework of the machine by a pivot shaft 114. An air cylinder 116 extends between the underside of the channel 113 and the base rail 35 of the machine frame, such that upon extension of the cylinder 116, the channel 113 is caused to pivot from a horizontal attitude to a vertical attitude about the

pivot shaft 114. This pivoting movement of the channel 113 occurs only after a spring assembly has moved onto the arm with the springs of the spring assembly supported from the top surface 112 of the monorail 29.

After the spring assembly has been moved onto the monorail 29 such that it is supported solely in the rotating mechanism 26 pneumatically actuated clamp cylinders 118 associated with the arm and supported therefrom are actuated so as to cause the pistons 120 of the cylinders to be pulled outwardly, thereby to clamp the border rods 6 of the spring assembly between the channel 113 and the pistons 120 of the cylinders. So clamped, the spring assembly may be rotated 90° from the horizontal phantom line position 122 indicated by the arrow 123 in Fig. 3 to the vertical phantom line position indicated by the members 124. Prior to this rotational movement, the pusher assembly 24 is moved rearwardly out of an interfering position relative to the spring assembly, such that the spring assembly 5 may be freely rotated 90° by rotation of the monorail 29 of the spring assembly. As explained more fully hereinafter in connection with the operation of the machine, the pusher 24 is moved rearwardly only so far as is required to avoid interference with the rotation of the spring assembly 5 through 90°. The distance the pusher assembly 24 is moved rearwardly is a function of the configuration of the mattress and the length of the side of the mattress to next be clipped in the clipping station 16 of the machine 10.

With reference now to Fig. 9, there is illustrated a second embodiment of the clip application machine 10. This second embodiment machine 10' of the machine is a horizontal machine, rather than a vertical one, the difference being that the mattress spring assembly is moved onto the machine in a horizontal attitude rather than a substantially vertical one. In this second embodiment of the machine 10', the same numerals have been applied to the same or corresponding elements, but followed by a prime (') mark to differentiate between the first embodiment of Figs. 1-8 and the second embodiment illustrated in Fig. 9.

In the use of the clip application machine 10', spring assemblies (not shown) are moved from the pre-clipped station onto the support plate 30' while the spring assembly is in a horizontal attitude and while the support plate 10 is located in a horizontal plane. The advantage of so moving the spring assembly in this position onto the support plate 30' is that the spring assemblies, before pre-clipping of the border rods, are in a horizontal attitude as they come out of the spring assembly machine. In this same horizontal attitude, the spring assemblies are moved from the assembly machine onto a horizontal pre-clip machine at which the corner clips are manually applied to the corners of the border rods and spring assembly. By moving the spring assembly in the horizontal attitude onto the support plate 30', the spring assembly never has to be lifted and converted from a horizontal attitude to a vertical attitude until after it is located in the clip application machine 10'. After being so located in the clip application machine, the rear edge 31' of the rear support plate is moved upwardly through an arc of approximately 25° about a pivot point at the front edge of the machine. This movement is effected by a pair of pneumatic cylinders 33' at each end of the machine (only one of which is illustrated). In the course of moving the support plate 30' from a horizontal attitude to a slightly downwardly inclined attitude from rear to front, the complete machine, including the monorail 28', the drive mechanism 18', and the clip application station 16, are also so rotated through a 25° angle. All that remains stationary is the frame 12' about which the rear support plate pivots.

In the use of this second embodiment of clip application machine 10', after completion of the application of clips to all four sides of the spring assembly (not shown), the support plate 30' is again

lowered to the horizontal attitude for removal of a completely clipped spring assembly from the machine and insertion of a new spring assembly ready for clipping.

The primary advantage of this second embodiment of clip application machine is that it minimizes the labor required to remove the pre-clipped mattress spring assembly from a pre-clipping table into the clip application machine 10'. Traditionally, that has been done manually, and in the case of large mattress spring assemblies, as for example, those which are king size, this can be very labor intensive.

The machines 10,10' are provided with a push button control panel 225,225' for starting and stopping the machine and a touch screen 203,203' for setting, adjusting and modifying the programmed functions of the machine 10,10'. The separate push button panel 225,225' as illustrated may be so provided or, alternatively, its functions may be incorporated into the tough screen controller interface 203,203'. For ease of access of the controls for programming the machine, the controls 203,203' and 225,225' are preferably positioned on the front of the machine 10,10'. At the front of the machine, the controls 203,203' and 225,225' are much more accessible than they would be if they remained on the side of the support plate 30 as in the first embodiment of the machine 10.

Machine Control System

The controls for the machine 10, according to the illustrated embodiment, are diagrammatically represented in Fig. 10. These controls include a controller 200, such as a programmable logic controller, that preferably includes a programmed processor 201, a volatile memory 202, a non-volatile memory 205 to which settings may be saved and from which data is loaded into the volatile memory 202, a touch screen user interface 203, a set 204 of outputs to the elements of the machine 10 that are to be controlled and sets 206-209 of inputs from sensors and other machine element condition indicators and from operator buttons and controls. The primary machine elements that are controlled in the operation of the machine 10 are the pusher assembly 24, the monorail 29 of the rotating mechanism 26, the clamp cylinders 108, 110 the spreader pins 104,106, the front gun 20, the rear gun 22 and a fault indicator 215. These are controlled by the various outputs 204 of the controller 200. The sensors and various indicators that generate signals to the controller 200 to inform the processor 201 of various machine or workpiece conditions or states include the digital optical encoder 84 that encodes the position of the pusher 24, pusher ZERO proximity sensor or switch 80 and OVERRUN position proximity 81, rotating mechanism monorail up and down proximity switches 223 and 224, the sensor 19, and various fault condition detectors. The inputs also include an operator switch panel 225. Further operator or supervisor information inputs and outputs are provided to and from the processor 201 through the interface 203.

The pusher 24, in the illustrated embodiment, is precisely positionable and moveable in a forward and a reverse direction on the rail 74 of the machine 10 above the monorail 28 to push a spring assembly 5 in the forward direction through the machine 10 and to return to a starting position along the monorail 28 of the support assembly 14. The pusher 24 of this embodiment is driven by a variable speed DC motor 60 that is controlled by an analog variable voltage signal on output line 204a from the controller 200, which controls the speed of the motor 60 through a directional relay 61. The voltage to the motor 60 can be set or varied to affect the speed of the pusher 24 on the monorail 28. The outlet 204a is connected through a standard analog interface card (not shown) of the controller 200. The motor 60 is bidirectional and its

direction is controlled by a direction relay 61, referred to as the ZERO position, which is controlled by a binary output 204b from the controller 200. The switch 80 signals the controller 200 on a binary input line 206a when the pusher 24 is at its maximum or extreme retracted position on the monorail 28, while the switch 81 signals the controller on a binary input line 206b that the pusher 24 is at or beyond its extreme forward position on the monorail 28.

Intermediate positions of the pusher 24 on the monorail 28 are determined by the program of the processor 201 of the controller 200 based on information from the encoder 84 and from the various settings within the memory 202. The encoder 84 is preferably a two channel optical encoder that generates a series of pulses for each predetermined increment of distance traveled by the pusher 24 on the monorail 28, with the outputs of the two channels being 90° out of phase, which permits the processor 201 to determine the direction of motion of the pusher 24 on the monorail 28. The outputs of the two channels of the encoder 84 are connected through input 209 through an encoder interface card in the controller 200. The interface card includes a pulse counter 230 register that can be read or reset by the processor 201, and contains a pulse count that represents the number of fixed increments of distance of the pusher 24 before or beyond the position at which the last setting of the counter 230 by the processor 201 occurred. This count corresponds to a known position of the spring assembly 5 on the monorail 28 relative to a reference point that preferably is the ZERO position. One or more additional inputs 206c are provided to signal the processor 201 of a stalled or other fault condition of the motor 60.

The spreader pins 104, 106 are operated by double acting pneumatic cylinders 108, 110, are actuated by solenoid controlled valve 109 to outwardly spread or actuated positions in response to a binary output 204c of the controller 200. The output 204c remains energized to hold the valve 109 in the position that moves the cylinders 108,110 and the spreader pins outward. When the output 204c is deactivated, or switched to a zero state, the solenoid controlled valve 109 is deactivated, its return spring moves the valve 109 to a position that causes the cylinders 108,110 to be driven inwardly to move the pins 104, 106 inwardly to their retracted positions.

Each of the guns 20, 22 is respectively controlled by a double acting pneumatic cylinder 21, 23, each controlled by a solenoid controlled pneumatic valve 181, 182, as illustrated in Fig. 7. Each cylinder 21, 23 has a forward stroke inlet port 183 and a return stroke inlet port 184, through which air flows inward when pressurized during the respective forward and reverse stroke actuation of the valves 181, 182, and from each of which air flows outwardly when the other port is pressurized. The reverse stroke inlet port 184 is connected to the valves 181 and 182 through a quick exhaust valve 185, which has a muffled exhaust port 186 venting directly to atmosphere. The forward stroke inlet port 183 of each valve 181 and 182 is similarly connected a quick release valve 187, which has an exhaust port 188 that vents through a flow restriction valve 189 to atmosphere.

The exhaust valves 185 allows air to exhaust quickly to atmosphere when the respective cylinder 21 or 23 is moving in the forward direction, while the exhaust valves 187 allow the respective cylinder 21 or 23 to return quickly in the reverse direction while providing controlled deceleration of the motions of the respective gun 20 or 22 on the return stroke. This permits rapid action of the guns 20, 22 while avoiding damaging impacts and excessive wear of the cylinders 21 and 23 and the clipper hammers on the return.

Solenoids of pneumatic cylinders of the front and rear guns 20 and 22 may each be double acting valves respectively controlled by a respective pair of binary outputs 204e, 204f and 204g, 204h to clip and release each respectively, or, in the alternative, the valves 181,182 may be single acting spring return valves, respectively controlled to fire the guns 20,22 by signals on outputs 206e and 206g, respectively, with the return outputs 206f and 206h replaced by return springs. The front and back guns 20, 22 are further respectively provided with a single acting spring return clip feed cylinder 21a,23a, respectively, which is actuated by air from port 184 of the cylinders 21 and 22. The cylinders 21a,23a, so actuated, feed a clip into each of the guns 20,22 after the gun has fired. Each such feed cylinder 21a,23a is provided with a detector 99 that connects to inputs 206e and 206f of the controller 200. These detectors 99 detect conditions such as an empty clip supply or a failure of the gun 20 or 22 to be fed a clip by the cylinders 21a,23a. Similar detectors may be provided to detect a failure of the guns to clip a coil spring to the border rod 6 or 7 when fired. Further, each of the guns 20, 22 is provided with one or more further cylinders (not shown) or other actuators, each respectively connected to a binary outlet 204i or 204j of the processor 200, to raise, lower, or otherwise position the gun 20, 22 to accommodate portions of the geometries of the various types of spring assembly units 5 that pass the guns 20, 22 on the monorail 28.

The monorail 29 of the rotating mechanism 26 is raised and lowered between an upper vertical position and a lower horizontal position by lift cylinder 116, which is a double acting cylinder actuated by a solenoid valve assembly 92 controlled by a respective pair of binary outlets 204k and 204l of the controller 200. The valve assembly 92 is provided with an exhaust outlet 93 that includes a solenoid controlled flow restriction device 94, controlled by binary outlet 204m of the controller 200, to slow the motion of the cylinder 91 at both ends of its stroke so that the rotating mechanism monorail 29 decelerates in a controlled manner to a stop at its raised and lowered positions. The presence of the rotating mechanism monorail 29 in its upper or raised position is detected by the switch 223, which connects to input 207a of the controller 200. The presence of the rotating mechanism monorail 29 in its lowered position is detected by the switch 224, which connects to input 207b of the controller 200. A spring assembly 5 is held to the monorail 29 by single-acting clamp cylinders 118 spaced along the monorail 29, which are actuated by a single solenoid controlled pneumatic valve 119 that is connected to output 204n of the controller 200. When activated, the clamp cylinders 118 pull and hold the clamps 118 in a clamped position. When the valve 119 is deactivated, the clamp cylinders 118, being spring biased, return to an open or released position.

The pusher 24 has a ZERO position near the front end of the monorail 28, at the left in Fig. 10 at which the pusher 24 should be located when a production run begins. The pusher 24 may be manually released by an operator and located by hand at this position. The control panel 225 is provided with a reset button 225a, which has one primary function of resetting to a zero a COUNT that is representative of the position of the pusher 24 on the monorail 28. This reset button 225a may also optionally cause the pusher 24 to return to the ZERO position. In addition, the reset button 225a may also cause the monorail 29 of the rotating mechanism to assume its lowered position and the other elements of the machine 10 to return to their initial positions in an operating cycle, which coincide with the positions of the elements of the machine 10 at which an operator would place or remove a spring assembly 5 onto or from the monorail 28 of the machine 10. The panel 225 also includes a start button 225b, which, when depressed by an operator, causes

the machine 10 to begin to cycle in the AUTO MODE described below, a stop button 225c, which, when depressed by the operator, causes the machine 10 to stop at any position in its cycle, and a pair of manual gun firing buttons 225d and 225e that respectively trigger the manual actuation of the clipping guns 20, 22, when the machine 10 is otherwise stopped.

The automated operation of the machine 10, the AUTO MODE, utilizes actual position sensing of the spring coils 8 of the spring assembly 5 by fiber optic non-contact spring coil sensor 19, which produces a binary signal on input 206g of the controller 200. The processor 201 uses the signal from the sensor 19 to trigger a reading of the counter 230, which reading is compared with various count settings stored in the memory 202 representative of the counts of the counter 230 that would correspond to various positions of the pusher 24 on the monorail 28. The settings are saved in the memory 202 and include, for example, memory location 202a, which stores the encoder count for a HOME position, which is an initial position for the pusher 24 at the start of a cycle that is predetermined for a spring assembly 5 of a particular type that is being manufactured by the operator. This setting corresponds to the number of encoder pulses that will be generated by the encoder 84 in moving the pusher 24 from the ZERO position to the HOME position for spring assembly units 5 of the particular type. This HOME position is set sufficiently far to the left in Fig. 10 to allow for the convenient placement and removal of a spring assembly 5 onto and from the monorail 28 of the spring support assembly 14 machine 10, but not so far to the left as to result in unnecessary delay for excess travel of the pusher 24 to and from the HOME position. The HOME position may be the ZERO position for any or all units.

The memory 202 also contains storage location 202b for storing the count for the pusher 24 return position for the ends (sides 2 and 4) of the spring assembly 5, which are the same, and location 202c for storing the count for the pusher 24 return position for the second long side (side 3) of the spring assembly 5. These positions, designated positions 3-RETURN and 2,4-RETURN, respectively, in Fig. 10, are located at a distance that is only sufficiently far to the left to allow the spring assembly 5 to clear the pusher 24 upon rotation by the monorail 29. As indicated in Fig. 3 by solid lines and by the phantom lines 124, 2,4-RETURN aligns with the trailing end of the assembly 5 and position 3-RETURN aligns with the trailing end of the assembly 5.

The memory 202 also includes storage locations that define the beginning and ends of window or CLIP area in which the coil sensor 19 is activated, so that it detects the presence of springs 8 that need to be clipped, thus causing the sensor to ignore the preclipped corner springs 8 that should not be clipped by the guns 20, 22. These locations are locations 202d and 202f that respectively store counts designating the 1,3-CLIP_START position and the 2,4-CLIP_START position, and memory locations 202e and 202g that respectively store counts designating the 1,3-CLIP_STOP and 2,4-CLIP_STOP positions. As with the HOME and RETURN positions, the CLIP_START and CLIP_STOP positions typically differ for the long and short sides of a spring assembly 5. For the same reason, storage locations 202h and 202i are provided to designate the positions at the beginning and end of the area of sides 1 and 3, 1,3-SPREAD_START and 1,3-SPREAD_STOP, respectively, between which the spreader pins cylinders 108, 110 are activated for long sides 1 and 3, while storage locations 202j and 202k are provided to designate the positions at the beginning and end of the area for sides 2 and 4, 2,4-SPREAD_START and 2,4-SPREAD_STOP, respectively, between

which the spreader pin cylinders 108, 110 are activated for the ends or short sides 2 and 4 of the spring assembly 5. In addition, there are provided in the memory 202 locations 202l and 202m are provided in which to optionally store the counts, 1,3-HOLDOUT_START and 1,3-HOLDOUT_STOP, designating areas within the CLIP area over which the guns 20,22 are otherwise to be disabled for long sides 1 and 3, and locations 202n and 202o are provided in which to store counts, 2,4-HOLDOUT START and 2,4-HOLDOUT STOP, designating areas within the CLIP area over which the guns 20, 22 are otherwise to be disabled for short sides 2 and 4. These HOLDOUT areas are provided to prevent the clipping of coils that would be otherwise detected by the coil sensor 19, such as might be desired where the unit type of the spring assembly 5 is hinged king size spring assembly, for example. Additionally, a number is stored to define the physical positions for each of the guns 20,22 at memory locations 202p and 202q, respectively, defined as variables DELAY-1 and DELAY-2. DELAY-1 represents the encoder count difference between the positions of sensor 19 and the front gun 20 while DELAY-2 represents the encoder count difference between the positions of sensor 19 and the rear gun 22.

Operation of the Machine

The operation of the machine is discussed in the context of the method of the invention for the making of spring assembly units 5. A production cycle of the machine 10 is herein considered to describe the manual and automated steps for the production of one such spring assembly 5. This production cycle is defined to include the hand preclipping of one spring assembly 5 by the operator, the placing by the operator of the preclipped spring assembly 5 onto the monorail 28, the execution of the automated machine production cycle in which the one preclipped spring assembly 5 is automatically clipped on all four sides, and the removal of the completed spring assembly 5 from the monorail 28 by the operator after the machine 10 has completed one production cycle.

The processor 201 is programmed to execute the automated production cycle as well as the to set the parameters of and otherwise control the movements of the machine 10. The controller is preferably a conventional programmed logic controller of the type typically programmed in ladder logic. The program, when executed, repeatedly executes a main program loop during which it checks all of the inputs, makes calculations based on the inputs while testing the programmed conditions and setting variables and flags, then alters the outputs accordingly. Since the cycle of the processor 201 is much faster than the production cycle of the machine, usually only one change of state of an input variable is likely to occur per each program loop. For simplicity, however, the overall production cycle that results from the repeated execution of the main loop of the processor program is illustrated in flowchart form. In the course of the discussion of the production cycle, the more important calculations and conditions for the changing of the output variables that are employed by the main loop of the processor program are described. In the course of the description, calculations and conditions executed by the program where irrelevant to at the particular point in the production cycle that is being described are omitted. Another form of programmed microprocessor based controller could execute the flowchart logic and control the machine functions based on the diagrams and description. Other programming methods can similarly be used.

At the beginning of a production cycle of the machine 10, the pusher 24 will either be at the ZERO position following pressing of the RESET button 225a by the operator, or will have automatically returned

to the HOME position following the completion of a cycle at the end of which a clipped spring assembly 5 was removed from the monorail 28 by the operator. When the operator has preclipped a spring assembly 5 and then placed the preclipped spring assembly 5 onto the monorail 28, the operator will press the START button 225b. The position settings for a particular spring assembly 5 type will have been stored in the memory locations 202a-202m in a manner that will be explained below. Upon starting a machine operating cycle, the program of the processor 201 will have verified that the elements of the machine 10 are in the correct initial positions for a cycle to begin,with the monorail 29 down, the guns 20,22 off, the spreader pins 104,106 are off or extended inwardly, all sensors outputting a zero state, all cylinder and valve solenoids off, the pusher 24 in the HOME position and the motor 60 off. At the beginning of the cycle, a SIDE variable is set equal to 1, designating that the first long side is to be clipped.

Referring to the flowchart of Fig. 11\,. the preferred operating cycle performed by the machine 10 in its AUTO MODE is represented. The operating cycle of the machine 10 begins with the operator pressing the START button 225b and ends with return of the pusher 24 to its HOME position and the automatic pausing of the machine 10. As the operating cycle of the machine 10 begins, the controller 200 checks all conditions and in response executes the CLIP A SIDE routine of Fig. 11A, which sends a signal on outlet 204a to energize the motor 60 and a signal on outlet 204b to set the direction relay 61 to FORWARD, causing the motor 60 to energize in its forward direction, thereby starting the movement of the pusher 24 in the forward direction. This movement of the pusher 24 continues as the processor 201 continues to repeat the CYCLE loop until the state of one of the inputs changes. Thus, the pusher 24 proceeds to engage a spring assembly 5 and push it through the machine 10. As the pusher 24 moves, the encoder 84 increments the COUNT stored in the counter 230, one increment for each predetermined increment of motion of the pusher 24. In the illustrated embodiment, one increment of the COUNT is equal to approximately 1/64th of an inch of movement of the pusher 24. Generally, increments should be sufficiently fine to allow determination of clip positions with accuracy needed for the clips to align properly. Increments of tenths of an inch are generally unacceptably course, while those in the order of one hundredths of an inch are usually adequate.

In the cycle of operation, as the pusher 24 moves the spring assembly 5 through the machine 10, the program of the processor 201 continues to execute the CYCLE loop, checking the COUNT in counter 230 and comparing it with the values stored in the memory locations 202a-202m. When the COUNT falls between the SPREAD_START and SPREAD_STOP values for a given side, which are initially the variables 1,3-SPREAD_START and 1,3-SPREAD_STOP with SIDE = 1, COUNT is compared with the values in locations 202h and 202i. If the comparison results in a determination that the COUNT is between these stored values, an output variable is set so that the spreader cylinders 108,110 will be activated. If the COUNT does not fall between these variables, an output variable is set so that the spreader pin cylinders 108,110 are deactivated. The spreader pins 104,106 are controlled so as to latch in its activated and deactivated states. Therefore, the program checks to determine whether or not the spreader pins 104,106 are already in the position that it is supposed to be in, and only if it is not is the output set to change the state of the spreader. In addition, preset variables are used by the program of the processor 201 to define

windows in which the spreader pins 104,106 may be activated or deactivated, so that no change of state of the spreader pins 104,106 will occur at other times.

Also in its program loop, the program of the processor 201 makes comparisons between COUNT and values 1,3-CLIP START and 1,3_CLIP_STOP in storage locations 202d and 202e. Further, if the unit type of the spring assembly is one that calls for the HOLDOUT area to apply, as will be flagged by the setting of a binary variable HOLDOUT to ON, then the COUNT is also compared with the 1,3-HOLDOUT_START and 1,3-HOLDOUT_STOP variables in locations 202l and 202m. If COUNT lies between the 1,3-CLIP_START and 1,3-CLIP_STOP positions and, if applicable, not between the 1,3-HOLDOUT_START and 1,3-HOLDOUT_STOP positions, then a variable is set that will cause the coil sensor 19 to be ENABLED. Otherwise, a variable is set to cause the coil sensor 19 to be DISABLED.

When the coil sensor 19 is ENABLED, the processor 201 monitors its output at controller input 206g. When the presence of a spring 8 is detected by the coil sensor 19, a COIL_DETECT flag is set to ON. In response to the setting of the COIL_DETECT flag to ON, the processor 201 sets a COIL_MARK variable to the value of the COUNT. Also, in the memory 202 are stored separate values for delays for the firing of the two guns 20,22 following the detection of a spring 8 by the coil sensor 19. The delays, DELAY_1 and DELAY_2, represent the differences in the values of the COUNT that correspond to the distance between the coil sensor 19 and the respective guns 20,22. The positions of the guns 20,22 behind the coil sensor 19, or the variables DELAY-1 and DELAY-2, are stored in memory locations 202p and 202q of memory 202. The values of the delays are different for the two guns 20,22 which do not fire at the same times. Preferably, the back gun 22 fires first, then when the back gun 22 has clipped spring 8 to the border rod 7 at the back, the front gun 20 is fired. To time the firing of the guns 20,22, the processor 201 executes the CYCLE loop until the COUNT equals COIL_MARK plus DELAY_2, whereupon a variable is set to trigger the back clip gun 22. Similarly, when the COUNT equals COIL_MARK plus DELAY_1, a variable is set to trigger the front clip gun 20. Once the guns 20,22 are triggered, sensors are checked at processor inputs 206e and 206f to insure that the guns 20,22 are not out of clips 9 and that the spring 8 has in fact been clipped. If a gun 20,22 is out of clips 9 or if a spring 8 has not been clipped, then a fault flag to identify the condition and to cause the machine 10 to stop, illuminating the fault light 215. The fault light 215 is optional in that the stopping of the machine 10 will usually make it apparent to the operator that a fault has occurred.

Also during each program loop, or at least toward the end of the forward stroke of the pusher 24, the COUNT is checked against an end of stroke setting, which corresponds to location of the pusher 24 a setting for the trailing end of the spring assembly 5 to be located on leading end of the monorail 29, indicating that the spring assembly 5 is complete and in position on the monorail 29 where it is ready to be turned 90°. If this condition does not occur before the OVERRUN proximity switch 81 is tripped, resulting in a signal at the input 206b of the processor 201 indicating that a monorail 29 overrun fault condition, the machine 10 stops and a fault flag is set. When the spring assembly 5 has been pushed entirely onto the monorail 29 and this condition is detected by the processor 201 during the execution of its cycle, which should occur only with the guns 20,22 and spreader pin cylinders 108,110 off and the coil sensor 19 disabled, the advance of the pusher 24 is stopped by removing power on the output 204a to the motor 60.

Then, the SIDE variable is incremented by 1, to SIDE=2, as the ROTATE routine of **Fig. 11B** is executed. This routine sets the direction relay 61 to REVERSE by a signal on the output 204b, then energizes the motor 60 by turning the output 204a on again, which outlet will remain on until the CYCLE loop detects that COUNT is no longer greater than the setting of the 2,4-RETURN variable, indicating that the pusher 24 has retracted to the return position for side 2. In the mean time, while the pusher 24 is returning to a return position, variables are set to activate solenoid valve 119 to actuate the clamp cylinders 118 by a signal on output line 204n, then to activate the monorail lift cylinder 116 with a signal on output line 204k. The lifting of the monorail 29 proceeds at high speed until the monorail 29 is almost in its uppermost position. This condition can be determined by a proximity switch to signal that the unit is nearing 90° of rotation. In the illustrated embodiment, however, the point at which the rotating monorail 29 is nearing the 90° position so that it can be slowed to a stop, so as not to throw the unit beyond this position, is determined by a timer set in the controller processor 201. The setting of this timer may be, for example, about 1.5 seconds for a typical unit of a given weight. This timer setting will be to a longer interval for heavier units and to a shorter interval for lighter units. Such a setting may be made from stored data when a unit type is selected, as discussed below.

The program, either by responding to a proximity switch or by checking such a timer variable to determine if it has timed out, determines that the monorail 29 is approaching the top of its stroke and sets a variable that will cause the activation of the cylinder exhaust restriction valve 94 by a signal on output 204m. The activation of the exhaust restriction valve 94 will slow the cylinder motion and cause the monorail 29 to ease toward the uppermost position. When at this uppermost position, having rotated the spring assembly 90° so that it is resting on side 2, the controller senses the closing of the monorail-up proximity switch 223 at input 207a. When the monorail 29 stops in its uppermost position, the clamps are opened by removing the signal from output line 204o of the controller 500 to deactivate the valve 119.

At this point, since the spring assembly 5 will have rotated on its corner between sides 1 and 2, where side 1 had rested entirely on the monorail 29, side 2 will rest on the monorail 28 immediately upstream of the monorail 29. The 2,4-RETURN position having been properly set, the rotation will place the corner of the spring assembly 5 between sides 2 and 3 on the monorail 28 immediately downstream of the pusher 24, which will by then have come to a stop at the 2,4-RETURN position. The ROTATE routine then continues by setting variables that will return the monorail 29 to the horizontal position by turning off the outlet 204m to the exhaust restriction valve 94 and turning off the outlet 204k and turning on the down direction outlet 204l to the monorail 29 lift cylinder 116, causing the monorail 29 to lower until another timer in the processor times out, after 1 1/4 second, for example, whereupon the exhaust restriction valve 94 is activated by a signal on outlet 204m to ease the monorail 29 toward its horizontal position. This timer setting may also vary somewhat with the unit type, and may be replaced with a proximity switch to signal the approach of the monorail 29 to the horizontal position. The ultimate horizontal position of the monorail 29 is signaled by the monorail-down proximity switch 224 on input 207b to the controller 200.

When side 2 is in position ready to be clipped, the CYCLE loop continues with the variable SIDE = 2, proceeding in the same manner as for SIDE = 1, as explained in detail above, using the set points of the variables 2,4-CLIP_START, 2,4-CLIP_STOP, 2,4-SPREAD_START, 2,4-SPREAD_STOP,

2,4-HOLDOUT_START, and 2,4_HOLDOUT_STOP. Then, the next detection of a signal from the OVERRUN switch 81 at inlet 206b of the processor 201, the motor 60 is caused to stop, SIDE is set equal to 3 and the ROTATE routine is again executed, with the pusher 24 returning to position 3-RETURN as the spring assembly 5 is rotated onto side 3, as explained above for the rotation onto side 2. Then, side 3 is clipped and the operation continues, rotating the spring assembly 5 onto side 4. When side 4 is complete, the pusher 24 returns to the HOME position, the spring assembly 5 is rotated onto side 1 and the machine 10 stops, completing the cycle.

In addition to the RESET button 225a and START button 225b, the operator has access to STOP button 225c from the control panel 225. Depression of the STOP button 225c stops the machine 10 at any point in its cycle. A pressing of the START button 225b after the operation has been stopped at any point other than at the beginning of the cycle, whether by a depression of the STOP button 225c or automatically by the detection of a fault in the operation of the machine 10, results in a restarting of the cycle at the point at which it was stopped. In this way, a partially completed spring assembly 5 can be completed from the point at which the operation stopped. Further, when the machine 10 is stopped, the operator may depress the manual clip gun firing buttons 225d or 225e for the front and back guns 20,22, respectively. This will cause a clip to be applied to the spring assembly 5 at whatever position it is in, such as the position in which it was in when the machine 10 stopped or at which it was manually moved by the operator. This provides the operator with an easy and rapid way to clip a spring 8 when a gun 20,22 has misfired or has run empty, causing the machine 10 to stop.

Machine Configuration

Additional controls are provided to the operator through a touchscreen of the interface 203 as illustrated in Fig. 12. These controls provide an operator with the capability of setting up or configuring the machine, for manually controlling the machine and for performing additional control functions. The interface 203 typically displays a MAIN menu 300, as for example is illustrated in Fig. 12A, that is accessible to an operators of various levels of training or responsibility. Behind the MAIN menu 300 are a series of sub-menus 301-310, each which may be made accessible to operators or technicians of different levels of training or responsibility. The MAIN menu 301 is provided with four display indicators 321-324 to inform the operator of machine 10 status while the machine 10 is cycling. The operation of the machine 10 in the CYCLE loop that is initiated by the depression of the START button 225b is referred to as the AUTO_MODE. When operating in this mode, until the machine 10 operation stops for one reason or another, causes the screen of the interface 203 to illuminate AUTO_MODE indicator 321. Whenever a spring 8 has been sensed by the sensor 19 and until a gun 20,22 has fired to clip that spring 8, COIL_SENSOR indicator 322 is illuminated. The flashing of the COIL_SENSOR indicator 322 while the AUTO_MODE indicator 321 is illuminated informs the operator that the operation is proceeding properly. Should any triggering of gun 20,22 fail to apply a clip 9 when it is supposed to, the appropriate REAR_CLIP_FEED_FAULT or FRONT_CLIP_FEED_FAULT indicator 323 or 324 will be illuminated, the machine 10 will stop and the AUTO_MODE indicator 321 will go off, informing the operator that the reason the machine 10 stopped was because of the failure to feed of a particular clip 9. The operator can

retrigger the appropriate gun 20,22 by pressing one of the buttons 225d or 225e take some other corrective action.

The MAIN menu 300 also includes programmed command buttons 326-328. The command buttons 326-328 include the ENTER_UNIT command button 326, the TEACH_UNIT command button 327 and the SETUP command button 328. Command button 326 allows the operator to select the type of spring assembly 5 that is to be run. By selecting the parameters defining a type of spring assembly 5, the operator tells the processor 201 which data to load for the various set points against which the processor 201 will compare the COUNT in order to control the machine elements during the operation of the main CYCLE loop of machine 10 operation. The pressing of ENTER_UNIT command button 326 on the screen of the interface 203 causes the MAIN menu 300 to be replaced by the SET_UNIT_TYPE menu 330, as illustrated in Fig. 12A. The SET_UNIT_TYPE menu 330 includes four option boxes 331-334 and one EXIT command button 335. The command button 335 causes a return to the MAIN menu 300. Within each of the option boxes 331-334 the operator has a plurality of options to select, which can be done by touching any of the displayed controls within the option boxes. When the SET_UNIT_TYPE menu first opens, the options displayed will default to the last unit type that had been selected, if any.

The option boxes 331-334 of the SET_UNIT_TYPE menu 330 include a UNIT_TYPE option box 331, a UNIT_SIZE option box 332, a LEGEND or STYLE option box 333 and a SPECIAL option box 334, which in the illustrated example is indicated and presenting a selection for a "Hinged King" feature. The UNIT_TYPE option box 331 includes buttons 337 and 338 respectively designated as "312" and "364", which are numbers defining specific unit types. For a large number of defined unit types, the option box 331 can be provided with a vertical scroll bar to facilitate type selection. By selecting one of these preprogrammed types, a table of values for the variables 202a-202q is designated. Additionally, the UNIT_SIZE option box 332 is provided with buttons 341-344 by which the operator may respectively select a unit size of "twin", "full", "queen" or "king". Each such selection results in the designation of a portion of the UNIT_TYPE table. Further, the LEGEND option box provides two commands 345 and 346 by which the operator can select "standard" or "extra long", which finally defines the data from the table to be loaded into the variables in memory 202. The "hinged king" feature is a feature provided in king size mattresses for an ability of the spring interior of the mattress to fold, thereby enabling the mattress to be moved in places where space is inadequate for a full king size mattress to pass. This feature results in the setting of the variable HOLDOUT = 1, as described in the discussion of the operating cycle above. This allows for the guns 20,22 to be disabled at the hinge area of the spring assembly 5, to accommodate the hinge. This feature is selected or deselected by touching the respective ON and OFF buttons 347 and 348 of the option box 334. When the return button 335 is touched, the last option selected within each of the option boxes 331-334 is selected, and the values for that option are loaded from a table in the non-volatile memory 205 to the memory locations 202a-202q in the memory 202.

From the MAIN menu 300, the operator is provided with the ability change the settings for the variables 202a-202q in the memory 202 by touching the TEACH_UNIT command button 307, which opens the TEACH SET_POINT menu 350. From the TEACH_SET_POINT menu 350, the operator can overwrite the values stored in any of the memory positions 202a-202q with the current value of the COUNT variable

by pressing the appropriate command button on the screen of the interface 203. Before overwriting the value in memory, however, the operator can alter the value of the COUNT variable by jogging the pusher 24 forward or backward through a pressing of either a JOG_REVERSE button 351 or a JOG_FORWARD button 352. In doing so, the operator can observe the position of the spring assembly 5 on the monorail 28 and the relation of its springs 8 to the guns 20,22 and coil sensor 19. When the operator observes that the spring assembly 5 is in the right position, the adjusted COUNT can be stored to the memory 202 to overwrite the selected variable.

Selection of the variable to overwrite with the adjusted COUNT value is provided through five option boxes 353-357 on the TEACH_SET_POINT menu 350 as illustrated in Fig. 12B. Box 353 is SIDE selection box which contains two buttons, including a 1,3-SIDE button 353a for selecting the long sides of the spring assembly 5 and a 2,4-SIDE button 353b for selecting the short sides or ends of the spring assembly 5. Box 354 is a RETURN position selection box which contains three buttons, including a HOME position set button 354a for selecting the HOME position for the unit type to write the COUNT value to storage location 202a, a 2,4-RETURN position set button 354b for selecting the storage location 202b and a 3-RETURN position set button 354c for selecting the storage location 202c. Option boxes 355-357 each contain a pair of command buttons 355a,355b, 356a,356b and 357a,357b for respectively selecting _START and _STOP positions for the CLIP, SPREAD and HOLDOUT positions. The selections of the option boxes 355-357 work in conjunction with the buttons of the SIDE selection box 353 to define the variable being selected.

Whenever one of the buttons of the boxes 354-357 is selected, the current value of the COUNT variable is stored in a temporary variable for the selected setting. A RETURN button 354 is provided for the operator to return to the MAIN menu 300. When the RETURN button 354 is pressed, the temporary values are stored into the storage locations for the corresponding variables in the volatile memory 202. The values stored in volatile memory 202 are lost when the machine 10 is turned off or reset or the unit type is again selected from the SET_UNIT_TYPE menu 330. However, the temporary variables can be saved to the non-volatile memory 205 through the selection of the DEFINE_UNIT button 359 on the TEACH_SET_POINT menu 350.

The DEFINE_UNIT button 359 results in the opening of the UNIT_NO menu 360. This menu is similar to the SET_UNIT_TYPE menu 330, and includes the UNIT_SIZE option box 332, the LEGEND or STYLE option box 333 and the HINGED KING or SPECIAL option box 334, which allow the selection of a unit type of a new unit to be defined or of a previously defined unit to be changed. However, in place of the UNIT_TYPE option box 331, the UNIT_NUMBER menu 360 is provided with a ENTER_UNIT_NO command button 361. When the operator presses the ENTER_UNIT_NO command button, a KEYPAD menu 362 is opened. The KEYPAD menu 362 includes ten digit entry keys 363 in a standard layout and a multi-digit numerical display register 364, which displays a multi-digit number entered on the keys 363. A CLEAR key 365 clears the register 364. An OK or ENTER key 366 accepts the number entered in the register 364 and returns to the UNIT_NO menu 360, returning the entered number as a unit number to a UNIT_NUMBER register 367 on the ENTER_UNIT_NO command button 361. A CANCEL key 368 on the KEYPAD menu 362 gives the operator the option of clearing the register 364 and returning a blank unit

number to the UNIT_NUMBER register 367 of the UNIT_NO menu 360. When a unit number is entered in the UNIT_NUMBER register 367, the operator can save the settings to a table in non-volatile memory 305 for the unit by pressing a SAVE command button 370. If the a unit of the same number and type already exists in the table in the memory 305, a dialog box (not shown) will be displayed asking the operator to confirm that the data should be overwritten. The operator may also press a DELETE command button 371 which will delete from the table in the memory 305 the data for the unit that corresponds to the unit number and type selected. Finally, the operator can return to the TEACH_SET_POINT menu 350 by pressing RETURN command button 372. If the RETURN button 372 is pressed without first pressing the SAVE or DELETE buttons 371 or 372, a dialog box (not shown) will ask to confirm that the new settings are not to be saved, in which case the new entries will not be saved in non-volatile memory 305, but will none the less remain the current settings that will be used if the operator exits from the TEACH_SET_POINT menu 350 presses the START button 225b which starts a machine operating cycle and places the machine in the AUTO MODE.

Access to the TEACH_SET_POINT menu 350 or the UNIT_NO menu 360, or the use of the SAVE or DELETE buttons 370 and 371, may be conditioned on the entry of a password. Password protection may be provided for any or all of the menu operations on the interface 203, and different password and security levels may be provided for each such menu or any command of the menu. When a password is to be required, the KEYPAD menu 362 will be opened and a message "Enter Password" will be displayed, which, if not entered correctly, will deny the requested function of the controls to the operator.

Returning again to the MAIN menu 300, a SETUP command button 328 is provided to open for the operator a SETUP menu 375. The basic SETUP menu 375 is a manual control screen through which the operator may move the pusher 24 manually or operate the guns 20,22 manually. To achieve this there are provided a set of command buttons 376-379, including a JOG_FORWARD bottom 376, a JOG_REVERSE button 377, a FIRE_FRONT_GUN button 378 and a FIRE_REAR_GUN button 379. As the pusher 24 is jogged forward and backward, the value of the COUNT variable is displayed to the operator in a POSITION register 380. The SETUP menu 375 is further provided with a RETURN button 381 to return the operator to the MAIN menu 300. In addition, an ADVANCED_SETUP button 382 is provided on the SETUP menu 375. This ADVANCED_SETUP button 382 opens an ADVANCED_SETUP menu 400.

Referring to **FIG. 12C**, the ADVANCED_SETUP menu 400 contains four command buttons 401-404 through which the operator can numerically set the various set points that are discussed in connection with the TEACH_SET_POINT menu 350. These buttons include a RETURN_SET button 401, a CLIP_AREA_SET button 402, a SPREAD_AREA_SET button 403, and a CLIP_DELAY_SET button 404.

The RETURN _SET button 401 opens a RETURN_POSITION menu 410. The RETURN_POSITION menu 410 includes buttons 411-413. Button 411 allows the operator to set the HOME position in memory location 202a. Button 412 allows the operator to set the 2,4-RETURN position in memory location 202b, while button 413 allows the operator to set the 3-RETURN position in memory location 202c. The RETURN_POSITION menu 410 also includes a button 415 that returns the operator to the ADVANCED_SETUP menu 400 and a button 416 that returns the operator to the MAIN menu 300.

The CLIP_AREA_SET bottom 402 opens a CLIP_AREA_SET menu 420. The CLIP_AREA_SET menu 420 includes buttons 421-428. Buttons 421-424 relate to the settings for sides 1 and 3, while the buttons 425-428 relate to the settings for the sides 2 and 4. Buttons 421 and 425 allow the operator to set the CLIP_START settings in memory locations 202d and 202f, respectively, while buttons 422 and 426 allow the operator to set the CLIP_STOP settings in memory locations 202e and 202g, respectively. Similarly, buttons 423 and 427, and buttons 424 and 428 allow the operator to set the HOLDOUT_START and HOLDOUT_STOP settings in memory locations 202l and 202n and locations 202m and 202q, respectively, for sides 1 and 3 and sides 2 and 4, respectively. The CLIP_AREA_SET menu 420 also includes a button 429 which returns the operator to the ADVANCED_SETUP menu 400 and a button 419 which returns the operator to the MAIN menu 300.

The SPREAD_AREA_SET bottom 403 opens a SPREAD_AREA_SET menu 430. The SPREAD_AREA_SET menu 430 includes buttons 431-434. Buttons 431-432 relate to the settings for sides 1 and 3, while the buttons 433-434 relate to the settings for the sides 2 and 4. Buttons 431 and 433 allow the operator to set the SPREAD_START settings in memory locations 202h and 202j, respectively, while buttons 432 and 434 allow the operator to set the SPREAD_STOP settings in memory locations 202i and 202k, respectively. The SPREAD_AREA_SET menu 430 also includes a button 435 which returns the operator to the ADVANCED_SETUP menu 400 and a button 436 which returns the operator to the MAIN menu 300.

The CLIP_DELAY_SET bottom 404 opens a CLIP_DELAY_SET menu 440, which provides the ability to set the delays necessary to account for the distances of the guns 20,22 from the coil sensor 19. This ability is not provided from the TEACH_UNIT_SETTINGS menu 350. The CLIP_DELAY_SET menu 440 includes buttons 441 and 442. The button 441 allows the operator to set a FRONT_CLIP_POSITION variable in memory location 202p while the button 442 allows the operator to set a REAR_CLIP_POSITION variable in memory location 202q. The CLIP_DELAY_SET menu 440 also includes a button 445 which returns the operator to the ADVANCED_SETUP menu 400 and a button 446 which returns the operator to the MAIN menu 300.

When ever one of the settings selection buttons on the menus 410, 420, 430 or 440 is pushed, the KEYPAD menu 375 is opened to receive numerical entry of the settings value from the operator. This menu functions in the same was as when called from the menus discussed above.

ADVANCED_SETUP menu 400 includes a DEFINE_UNIT button 406 which, as with the TEACH_UNIT_SETTINGS menu 350, also results in the opening of the UNIT_NO menu 360. The UNIT_NO menu 360, when called from the ADVANCED_SETUP menu 400, operates in the same manner as when called from the TEACH_UNIT_SETTINGS menu 350, providing the operator with the capability of defining new units and the settings therefor, including the saving, changing and deletion of settings.

Other parameters may be set for each unit type. For example, when timers are used to determine the position of the rotating monorail 29, for example, because heavier units take slightly longer to be rotated by the monorail 29, the time-out intervals of the timers may be made settable by an advanced operator through the interface 203, preferably through a subscreen of the ADVANCED_SETUP menu 400. Such

settings would be stored memory 202, and preferably also non-volatile memory 205 with the other parameters for the unit type.

The TEACH menu provides the operator with the ability to recalibrate the set points for existing units to account for variances in the responses from machine to machine. In addition, provision is made for the transfer of settings from machine to machine, using the TEACH menu on the first machine, then writing down or otherwise recording, in machine readable or non-readable form, such settings. The recorded settings may then be entered on another machine, either manually using the ADVANCED SETUP mode or by storing the data in the second machines memory from recorded data on a transfer medium. Alternatively, the settings can be downloaded to a computer and uploaded to another machine 10. This can be done by connecting a portable computer to a data, e.g. serial, port of the controller 200 of one machine 10, downloading the settings, disconnecting and reconnecting the computer to another machine 10 and uploading the settings. Also, a computer can be provided on line, connected to all machines, such as through a network. In such a way, set point data can be transferred among machines. However, a useful feature of a networked computer so connected is to provide monitoring and production data, such as that which would account for the number of units completed, particularly, the numbers of units of each type that have been completed. Such a computer can also monitor productivity, record downtime and error rates or acquire other data that can be used to improve cost or productivity.

While we have described only two embodiments of our invention, persons skilled in this art will appreciate numerous changes and modifications which may be made without departing from the spirit of our invention. Therefore, we intend to be limited only by the scope of the following appended claims.

We claim:

1. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

a control system for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof without any stoppage of the spring assembly during passage of said edge through the clip application station.

2. The machine of claim 1 wherein said clip application station includes two clip application guns, said control system being operable to actuate said two guns sequentially to apply clips to opposite ends of the same spring while located in said clip application station.

3. The machine of claim 2 wherein each said clip application gun includes a double acting, pneumatic cylinder for actuating said gun.

4. The machine of claim 1 which further includes rotating means for sequentially rotating the mattress spring assembly and the border rods through 90° of rotation to present a different edge of the mattress spring assembly and border rods to said clip application station after passage of an edge of the spring assembly through the clip application station.

5. A machine for securing border rods on mattress spring assemblies, which spring assemblies each comprise a matrix of rows and columns of intermediate coil springs, said springs each having a pair of opposed end turns interconnected by intermediate revolutions of said springs, said machine comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

a control system for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof; and

said support rail comprising a monorail operative to engage and support the spring assembly from intermediate revolutions of said springs along said one edge of said spring assembly without contacting the end turns thereof.

6. The machine of claim 5 wherein said control system includes a fiber optic switch for detecting the entrance of springs into the clip application station.

7. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least two clip application guns longitudinally offset from one another along the direction of passage of said spring assembly through said machine;

a drive system for advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

a control system for detecting the entrance of springs into the clip application station and for actuating said at least two clip application guns in sequence in response to said detection to apply two clips to opposite end turns of each detected spring sequentially, whereby said end turns of multiple coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof.

8. The machine of claim 7 wherein said drive system is operative to continuously advance said mattress spring assembly through the clip application station without any stoppage of said assembly for application of said clips to said spring assembly.

9. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

sensor means for detecting the entrance of springs into the clip application station; and

a control system including an electrical encoder and programmable controller for actuating said at least one clip application gun in response to a signal from said sensor means, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof without any stoppage of the spring assembly during passage of said edge through the clip application station.

10. The machine of claim 9 wherein said control system is programmable for differing configurations of spring assemblies such that said sensor means need never be moved or repositioned in order for said machine to apply clips to said differing configurations of spring assemblies.

11. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods preclipped at the corners on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

a control system for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge; and

said clip application station including movable border rod puller means located at said clip application station upstream of said clip application gun, said border rod puller means being operative to pull a border rod away from said end turns of said coil spring of said spring assembly during passage of said spring assembly through said clip application station.

12. The machine of claim 11 wherein said border rod puller means is operative to pull said border rod away from said end turns only once during the passage of said edge through said clip application station.

13. The machine of claim 11 wherein said border rod puller means is operative to pull a border rod outwardly away from said end turns after passage of a leading preclipped corner of said spring assembly past said puller means and move inwardly toward said end turns of said spring assembly prior to arrival of a trailing pre-clipped corner of said spring assembly at said puller means.

14. The machine of claim 11 which further includes rotating means for sequentially rotating the mattress spring assembly and the border rods through 90° of rotation to present a different edge of the mattress spring assembly and border rods to said clip application station after passage of an edge of the spring assembly through the clip application station.

15. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

a control system including a fiber optic sensor fixedly positioned at said clip application station for detecting the entrance of a spring into the clip application station and a programmable control for actuating said at least one clip application gun in response to detection of the entrance of a spring into the clip application station.

16. The machine of claim 15 wherein said clip application station includes two guns located on opposite sides of said supporting rail.

17. The machine of claim 15 which further includes rotating means for sequentially rotating the mattress spring assembly and the border rods through 90° of rotation to present a different edge of the mattress spring assembly and border rods to said clip application station after passage of an edge of the spring assembly through the clip application station.

18. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

drive means for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

control means for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along said edge of the mattress spring assembly are successively secured to the border rods along said edge thereof without any stoppage of the spring assembly during passage of said edge through the clip application station.

19. A machine for securing border rods on mattress spring assemblies, which spring assemblies each comprises a matrix of rows and columns of intermediate coil springs, said springs each having a pair of opposed end turns interconnected by intermediate revolutions of said springs, said machine comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

drive means for advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

control means for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof; and

said support rail comprising a monorail operative to engage and support the spring assembly from intermediate revolutions of said springs along said one edge of said spring assembly without contacting the end turns thereof.

20. The machine of claim 19 wherein said control means includes a fiber optic switch for detecting the entrance of springs into the clip application station.

21. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least two clip application guns longitudinally offset from one another along the direction of passage of said spring assembly through said machine;

drive means for advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

control means for detecting the entrance of springs into the clip application station and for actuating said at least two clip application guns in sequence in response to said detection to apply two clips to opposite end turns of each detected spring sequentially, whereby said end turns of multiple coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof.

22. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

drive means for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

sensor means for detecting the entrance of springs into the clip application station, and control means including an electrical encoder and programmable controller for actuating said at least one clip application gun in response to a signal from said sensor means, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof without any stoppage of the spring assembly during passage of said edge through the clip application station.

23. The machine of claim 22 wherein said control means is programmable for differing configurations of spring assemblies such that said sensor means need never be moved or repositioned in order for said machine to apply clips to said differing configurations of spring assemblies.

24. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods preclipped at the corners on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

drive means for advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

control means for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge; and

said clip application station including movable border rod puller means located at said clip application station upstream of said clip application gun, said border rod puller means being operative to pull a border rod away from said end turns of said coil springs of said spring assembly during passage of said spring assembly through said clip application station.

25. The machine of claim 24 wherein said border rod puller means is operative to pull a border rod outwardly away from said end turns after passage of a leading preclipped corner of said spring assembly past said puller means and move inwardly toward said end turns of said spring assembly prior to arrival of a trailing preclipped corner of said spring assembly at said puller means.

26. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support means for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support means including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

drive means for continuously advancing the mattress spring assembly and the border rods along the support rail through the clip application station; and

control means including a fiber optic sensor fixedly positioned at said clip application station for detecting the entrance of a spring into the clip application station and a programmable control for actuating said at least one clip application gun in response to detection of the entrance of a spring into the clip application station.

27. A machine for securing border rods on mattress spring assemblies comprising:

a mattress spring assembly and border rod support for supporting a mattress spring assembly having border rods positioned in opposed relation on opposite sides thereof, said support including a supporting rail against which one edge of said spring assembly rests during passage through said machine;

a clip application station at which sheet metal clips are wrapped on the border rod and end turns of coil springs of the mattress spring assembly along said one edge to secure the border rods to the mattress spring assembly, said clip application station including at least one clip application gun;

a drive system for advancing the mattress spring assembly and the border rods along the support rail through the clip application station;

a control system for detecting the entrance of springs into the clip application station and for actuating said at least one clip application gun, whereby said end turns of the coil springs along the edge of the mattress spring assembly are successively secured to the border rods along said edge thereof; and

said support including a support plate movable between a first mattress spring assembly receiving position in which said plate is located in a horizontal plane and a second mattress spring assembly advancing position in which said support plate is located in an inclined plane.

28. The machine of claim 27 which further includes motor means for moving said support plate between said first and second positions.

29. A method for securing border rods on the end turns of coil springs of a mattress spring assembly, comprising:

providing a support, including an edge supporting rail for supporting a mattress spring assembly and border rods while one edge of the mattress spring assembly is moved over said supporting rail;

continuously advancing said edge of the mattress spring assembly and border rods along the support rail to and through a clip application station

detecting the presence of an edgemost spring of the spring assembly at the clip application station, and in response to said detection, wrapping a sheet metal clip about the border rod and the detected spring;

continuing the advance of said edge of the mattress spring assembly and border rods along the support rail and successively wrapping clips about the border rod and multiple springs along said edge of the mattress innerspring assembly without ever interrupting the continuous advance of said edge along said support rail until said multiple springs of said edge are wrapped by sheet metal clips and connected to the border rod along said edge.

30. The method of claim 29 which further includes the step of rotating the mattress spring assembly and border rods through 90° after sheet metal clips have been applied to the springs along said edge of said innerspring assembly.

31. A method for securing border rods on the end turns of coil springs of a mattress spring assembly, which coil springs each have opposed end turns connected by intermediate revolutions of said springs, which method comprises:

providing a support, including an edge supporting rail for supporting a mattress spring assembly and border rods while one edge of the mattress spring assembly is moved over said supporting rail;

continuously advancing said edge of the mattress spring assembly and border rods along the support rail to and through a clip application station;

detecting the presence of an edgemost spring of the spring assembly at the clip application station, and in response to said detection, wrapping a sheet metal clip about the border rod and the detected spring;

continuing the advance of said edge of the mattress spring assembly and border rods along the support rail and successively wrapping clips about the border rod and multiple springs along said edge of the mattress innerspring assembly; and

supporting the coil spring assembly in its advancing movement along the support rail from said intermediate revolutions of the coil springs which are located along said one edge of said spring assembly and without any contact of the end turns of said coil springs with said support rail.

32. The method of claim 31 wherein the detecting of the presence of an edgemost spring is effected by the breaking of a light beam emitted from a fiber optic switch element.

33. A method for securing border rods on the end turns of coil springs of a mattress spring assembly, comprising:

providing a support, including an edge supporting rail for supporting a mattress spring assembly and border rods while one edge of the mattress spring assembly is moved over said supporting rail;

advancing said edge of the mattress spring assembly and border rods along the support rail to and through a clip application station having two clip application guns for applying clips to opposite ends of edgemost springs of said spring assembly, said guns being longitudinally offset from one another in the direction of advancing movement of said spring assembly through said clip application station;

detecting the presence of an edgemost spring of the spring assembly at the clip application station, and in response to said detection, sequentially wrapping two sheet metal clips about the border rod and each detected spring;

continuing the advance of said edge of the mattress spring assembly and border rods along the support rail and successively wrapping clips about the border rod and multiple springs along said edge of the mattress innerspring assembly until said multiple springs of said edge are wrapped by sheet metal clips and connected to the border rod along said edge.

34. The method of claim 33 which further includes the step of rotating the mattress spring assembly and border rods through 90° after sheet metal clips have been applied to the springs along said edge of said innerspring assembly.

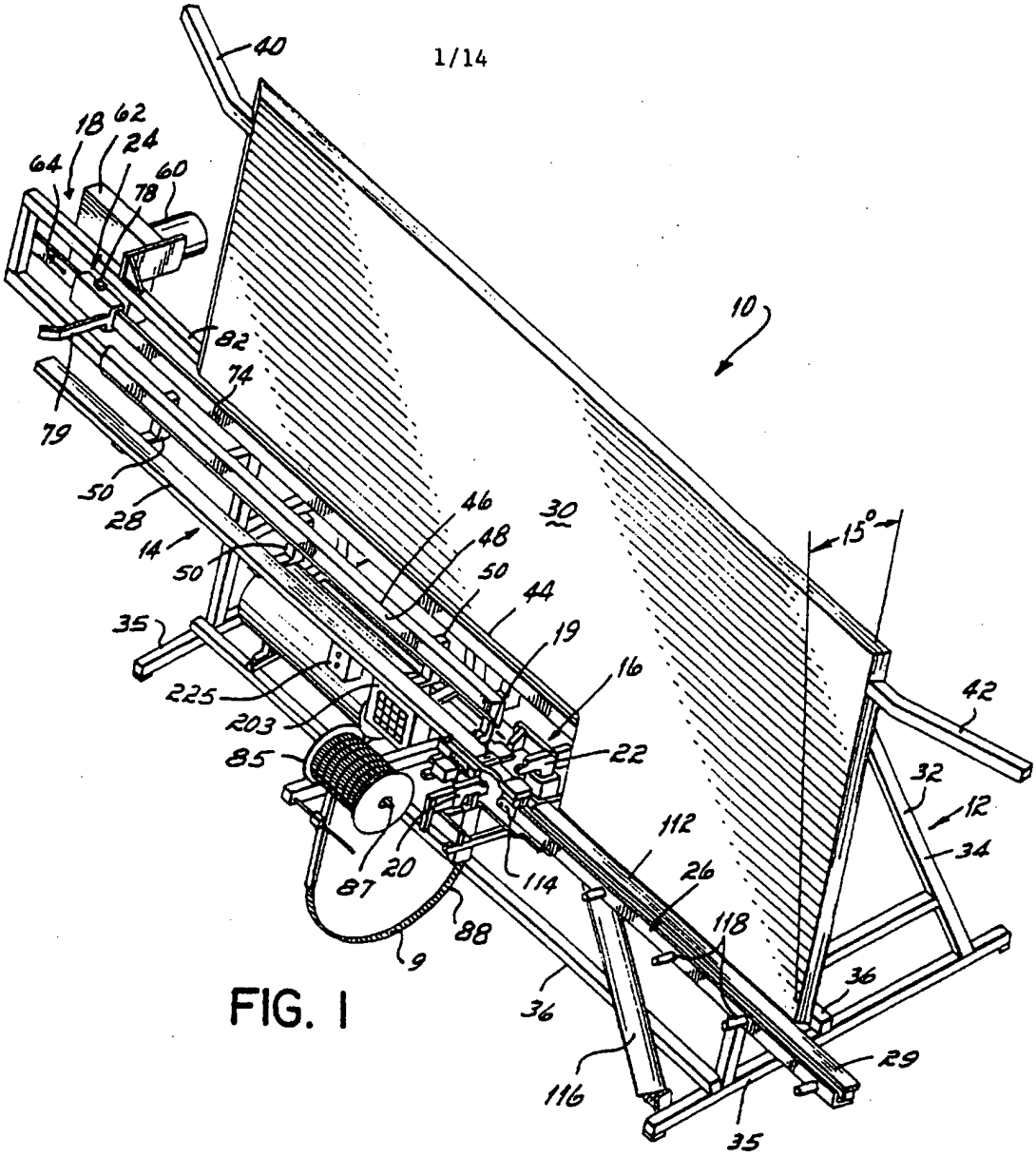

40
18
62
24
64
60
78
82
74
79
50
28
14
50
46
48
50
44
30
15°
35
19
16
225
203
85
22
42
32
12
34
112
26
114
87
20
88
9
118
36
36
116
29
35

FIG. 1

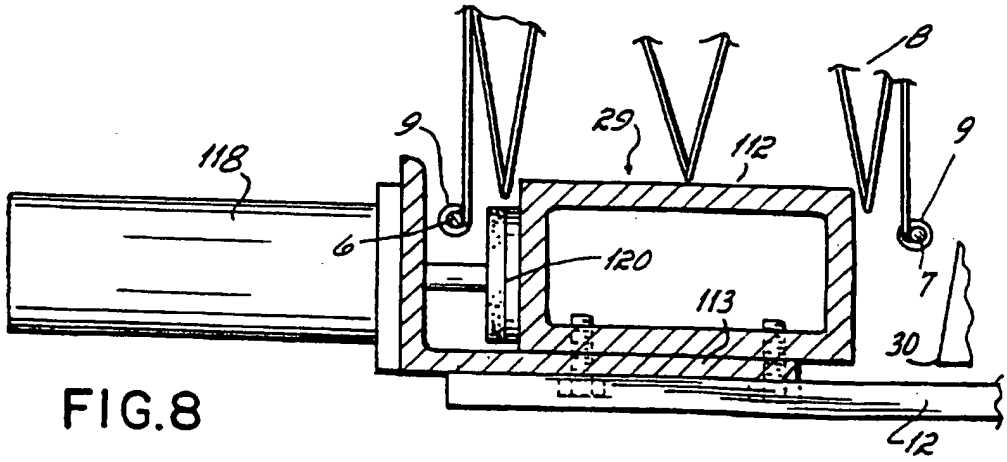

118
9
29
112
18
9
6
120
113
7
30
12

FIG.8

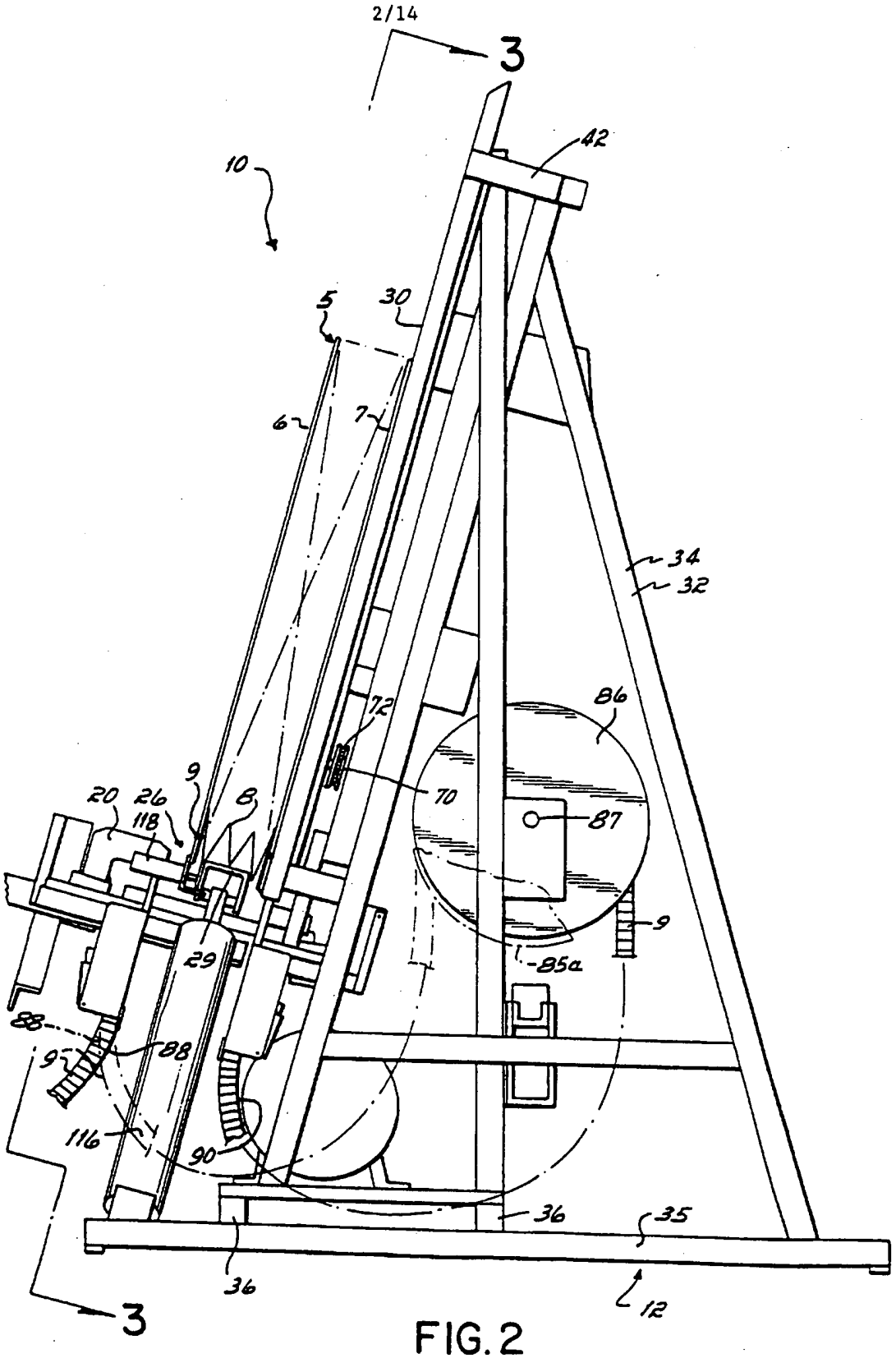
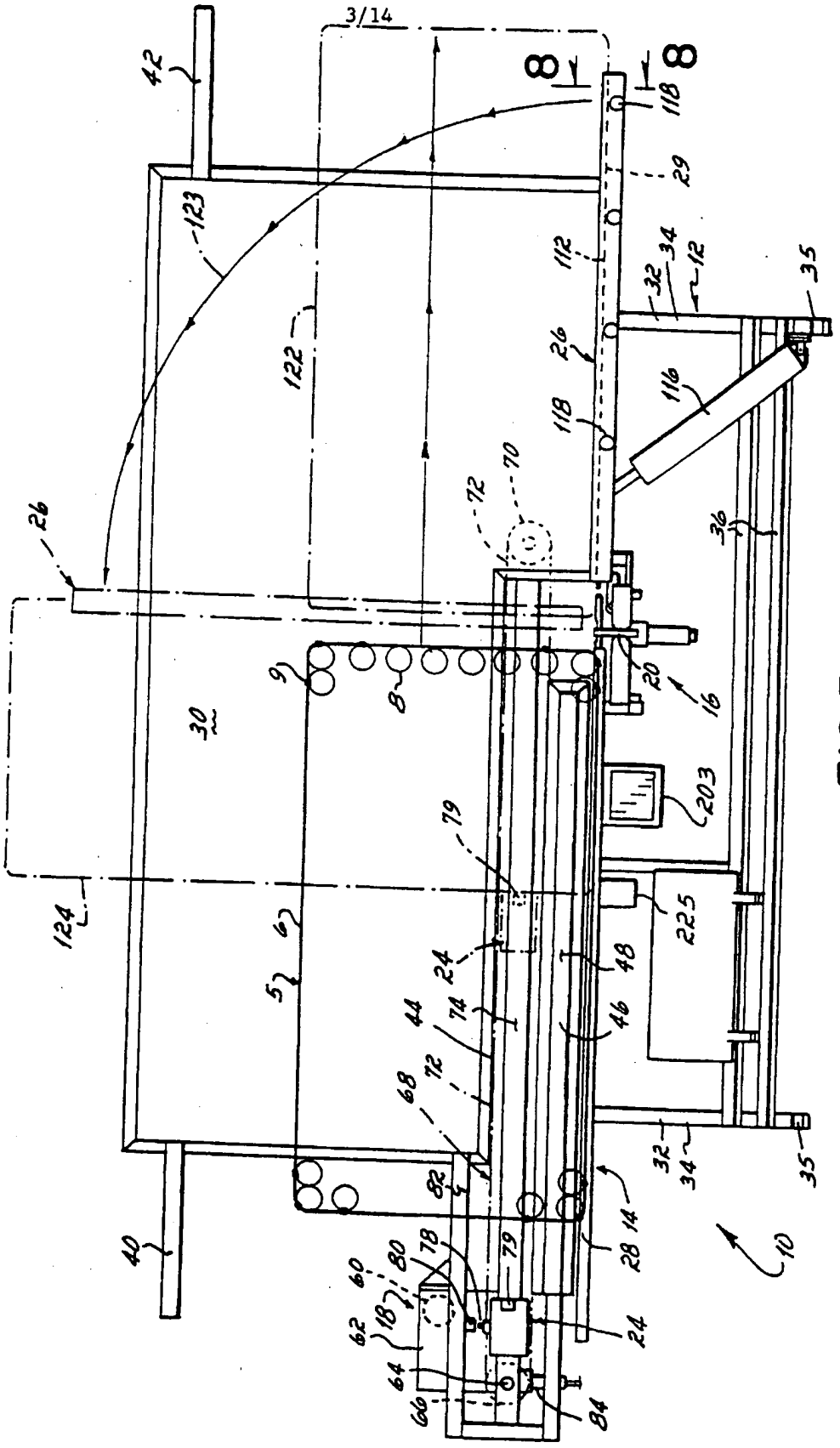

3
42
10
5
30
6
7
34
32
86
72
9
20
26
118
8
70
87
9
85a
29
88
9
88
116
90
36
35
36
12
3

FIG. 2


3/14
8
8
42
118
29
123
112
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12
35
32
122
26
116
118
70
72
26
36
9
8
20
16
30
203
79
225
124
62
5
24
48
74
44
46
68
72
82
32
34
35
40
14
28
10
80
78
79
60
62
18
24
64
66
84

FIG. 3

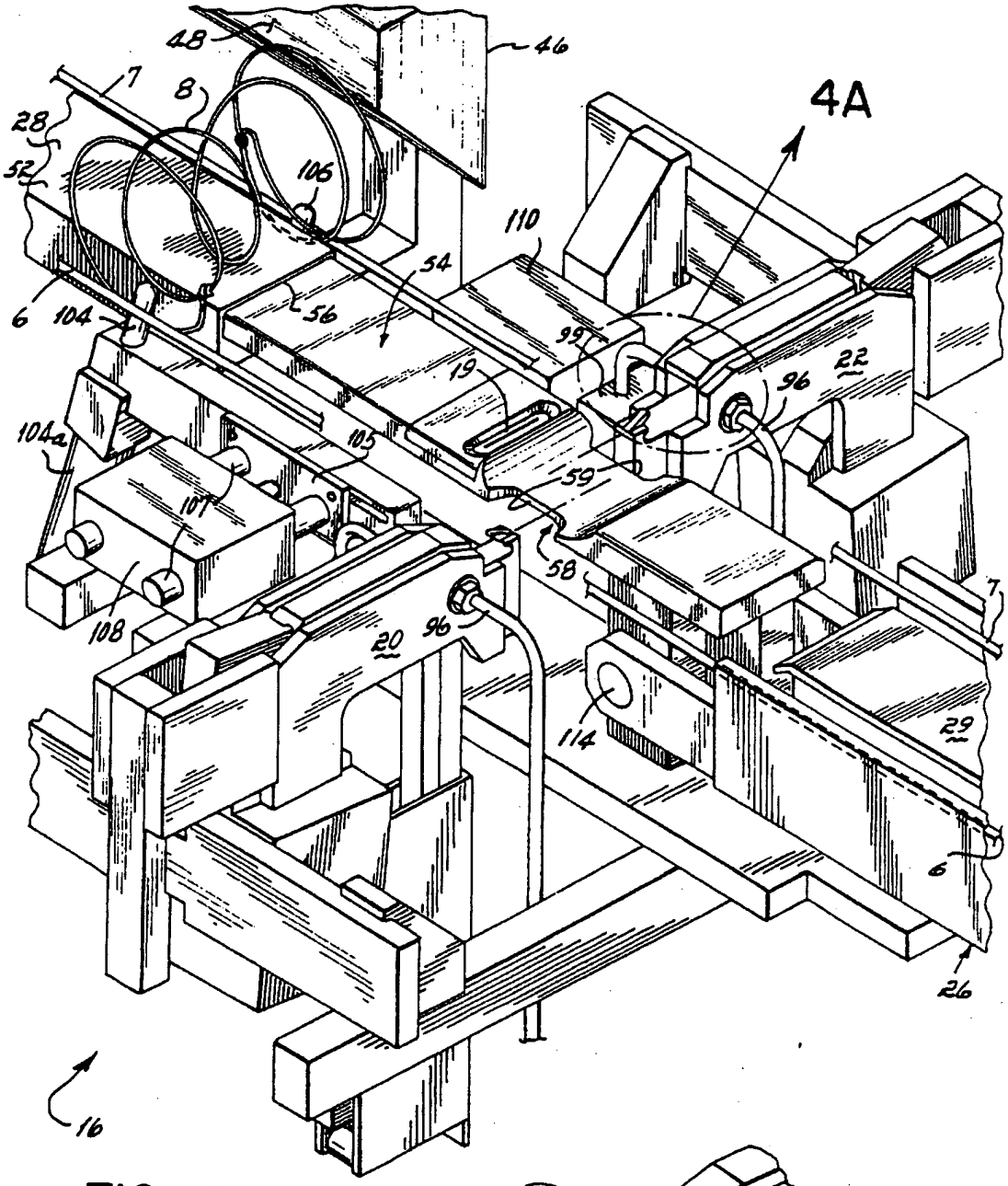

48
46
7
8
28
52
106
4A
110
54
6
104
56
99
19
22
96
104a
105
59
101
58
108
20
96
7
114
29
6
26
16

FIG. 4

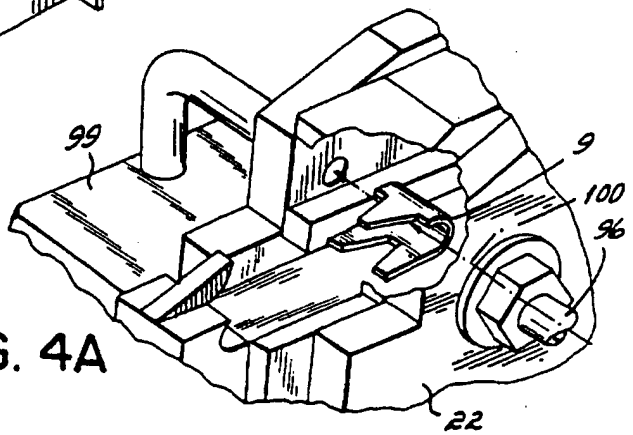

99
9
100
96
22

FIG. 4A

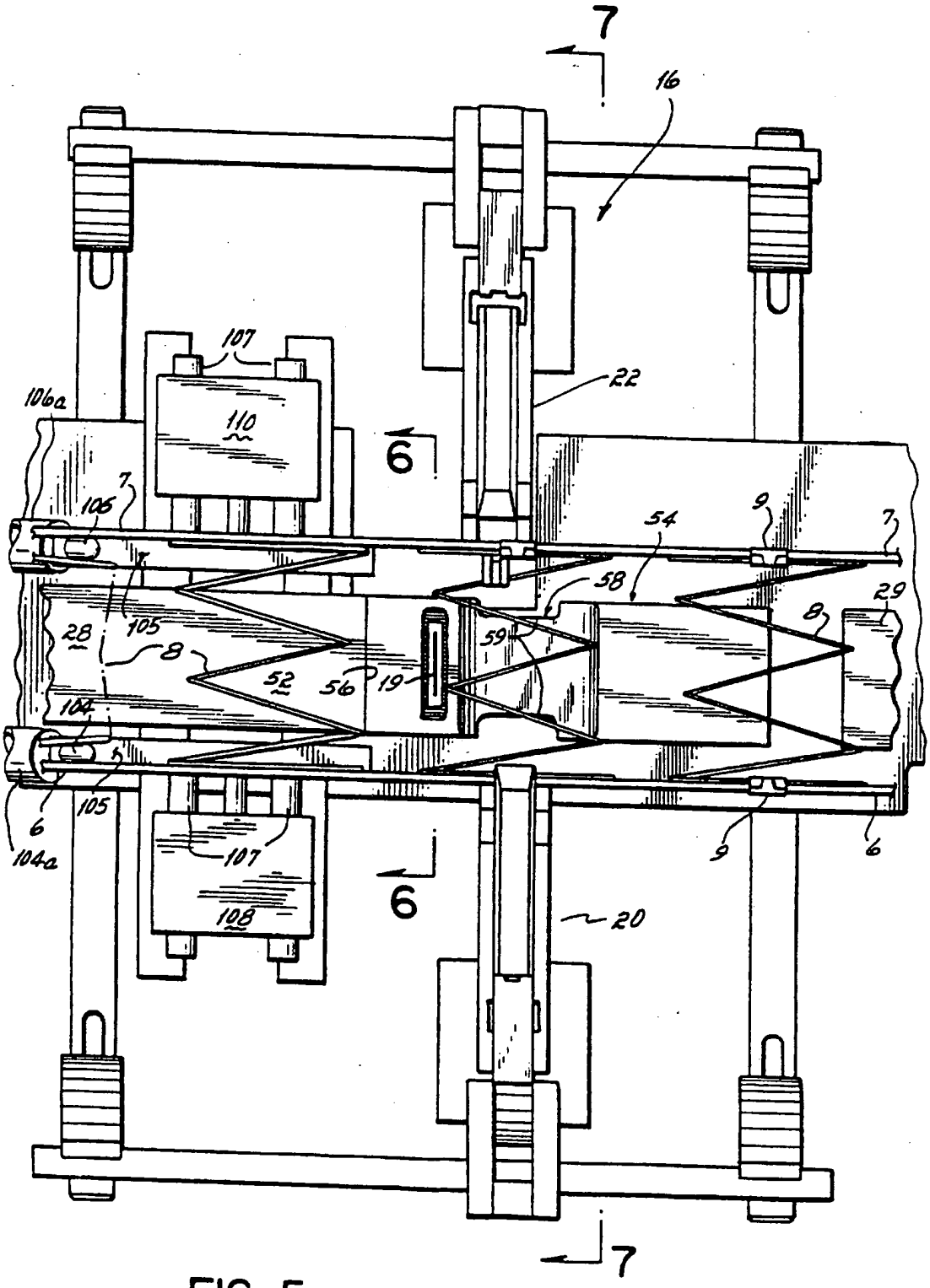

7
16
107
106a
110
22
6
7
105
54
9
7
58
29
28
105
8
59
8
52
56
19
104
105
6
104a
107
108
6
20
9
6
7

FIG. 5

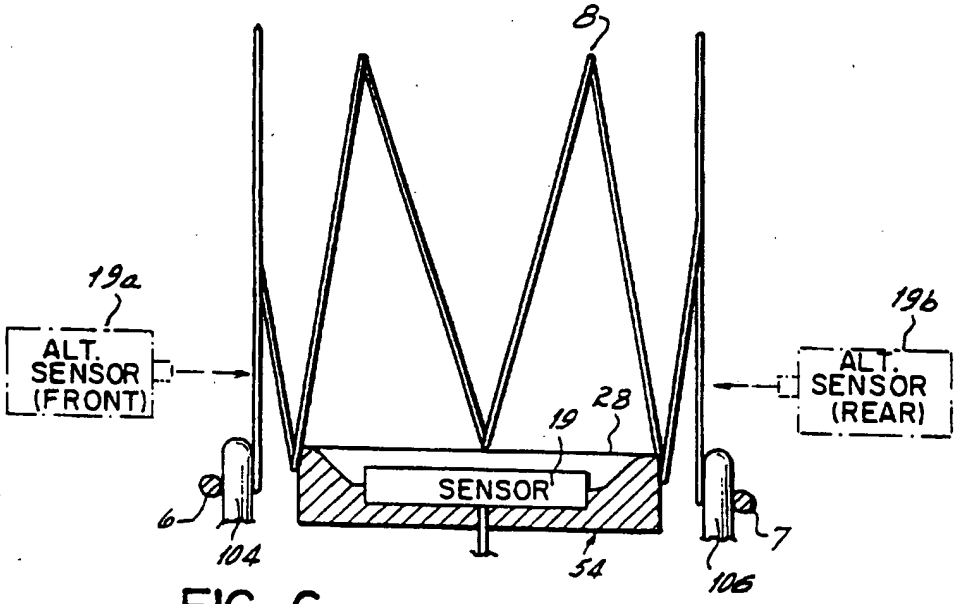

8
19a
ALT. SENSOR (FRONT)
19b
ALT. SENSOR (REAR)
19
28
SENSOR
6
7
104
54
106

FIG. 6

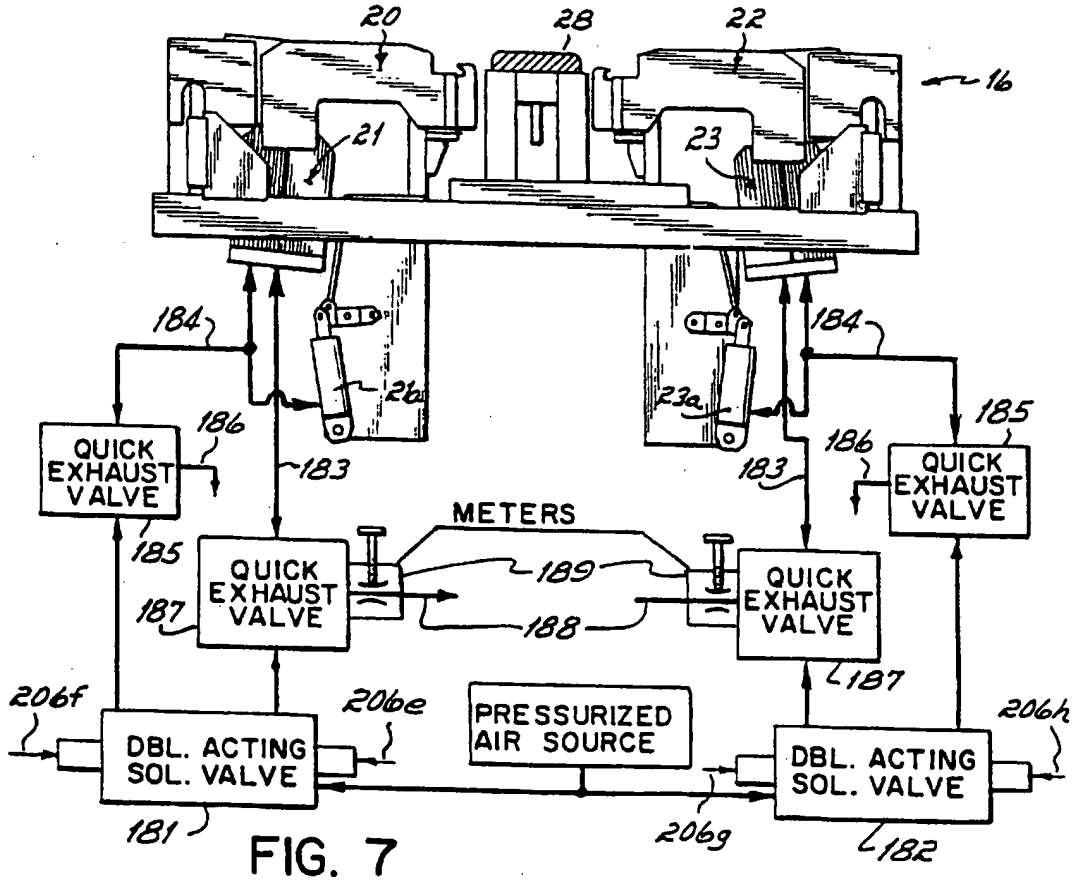

20
28
22
16
21
23
184
184
21a
23a
185
186
186
QUICK EXHAUST VALVE
183
183
QUICK EXHAUST VALVE
METERS
185
189
QUICK EXHAUST VALVE
QUICK EXHAUST VALVE
187
188
187
206f
206e
PRESSURIZED AIR SOURCE
206h
DBL. ACTING SOL. VALVE
DBL. ACTING SOL. VALVE
181
206g
182

FIG. 7

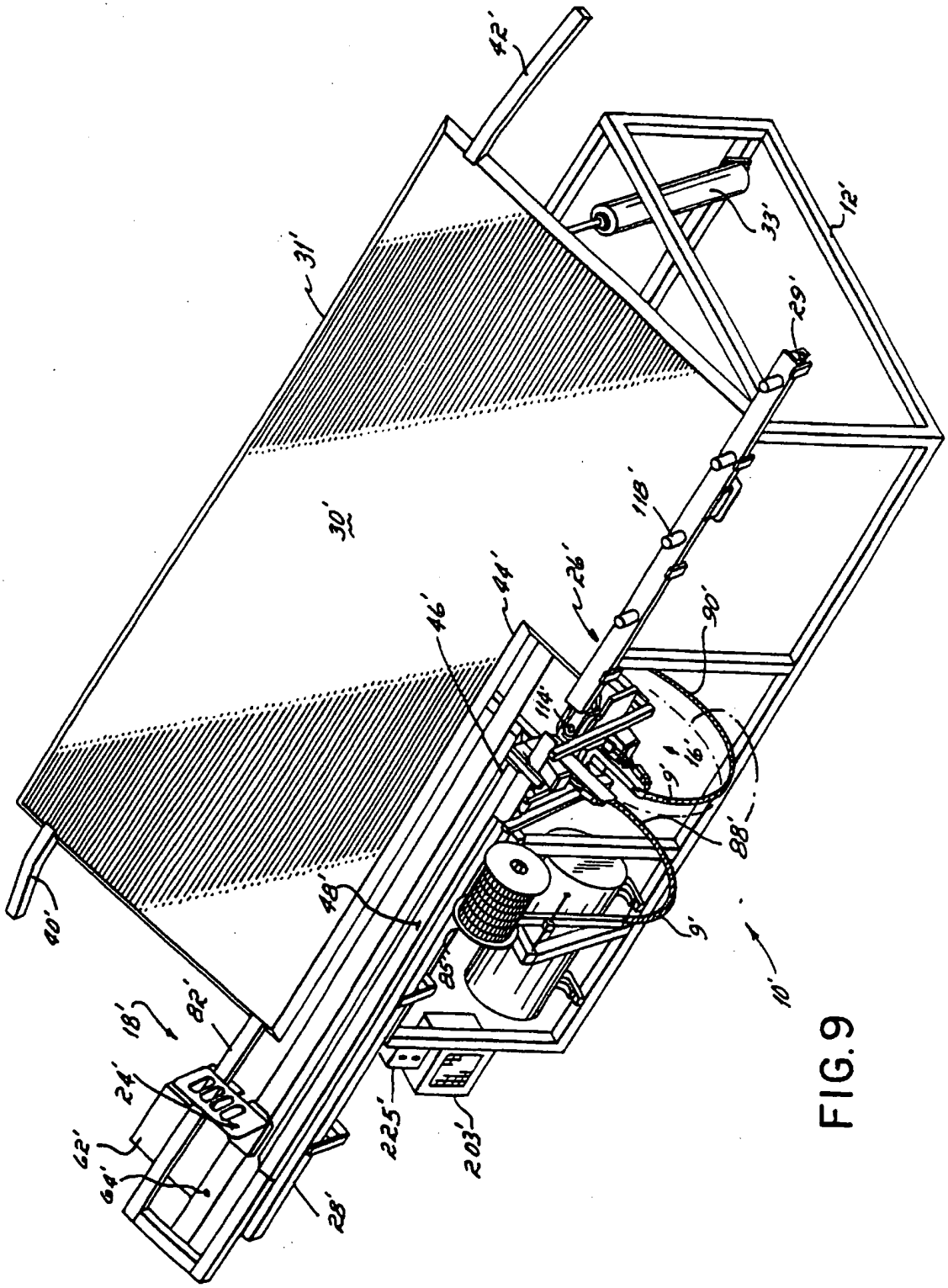
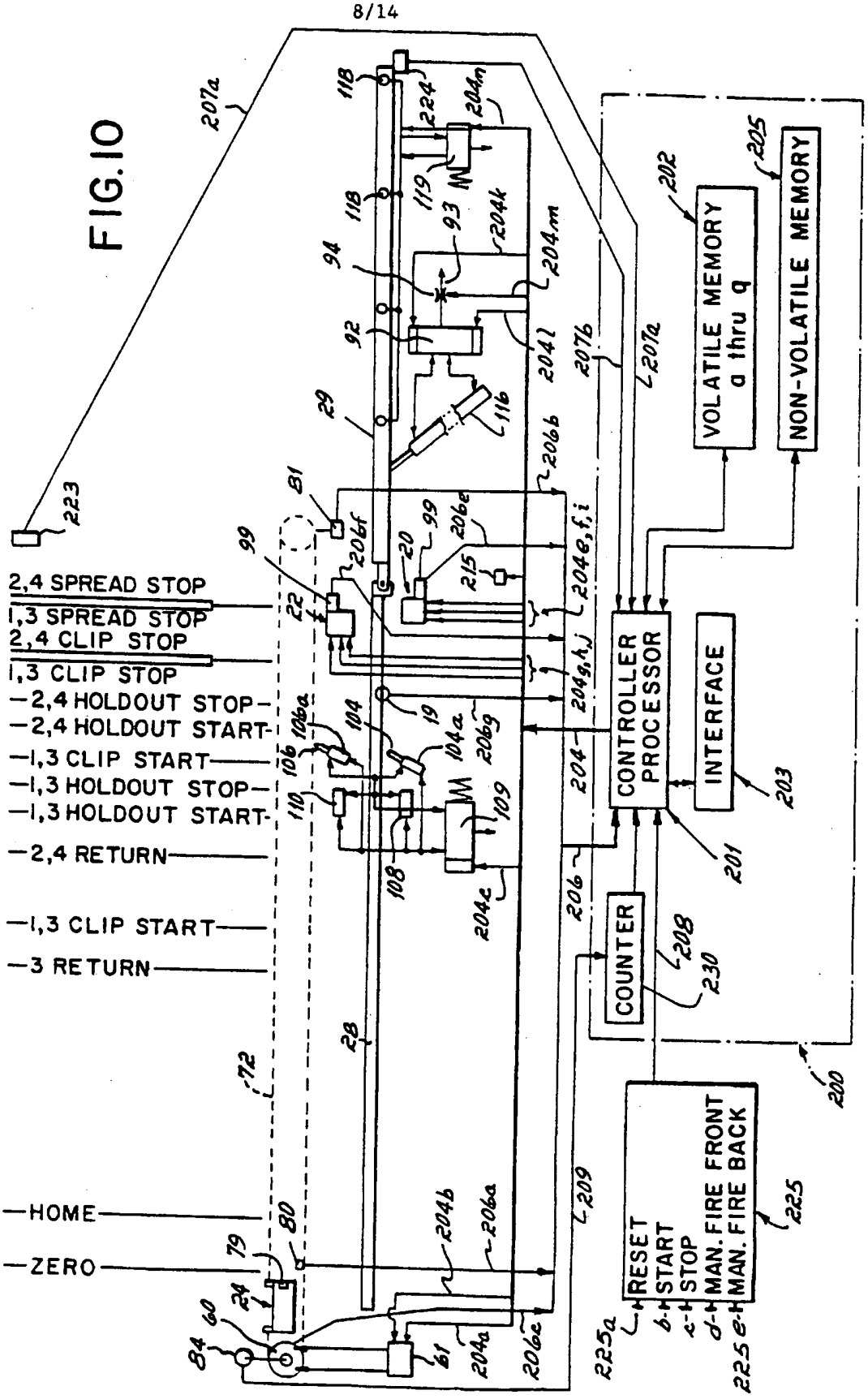

42'
31'
33'
12'
29'
30'
118'
44'
26'
46'
90'
114'
16'
9'
98'
48'
9'
10'
40'
18'
82'
24'
62'
64'
28'
225'
203'

FIG.9

FIG. 10


2,4 SPREAD STOP
1,3 SPREAD STOP
2,4 CLIP STOP
1,3 CLIP STOP
2,4 HOLDOUT STOP
2,4 HOLDOUT START
1,3 CLIP START
1,3 HOLDOUT STOP
1,3 HOLDOUT START
2,4 RETURN
1,3 CLIP START
3 RETURN
HOME
ZERO
CONTROLLER PROCESSOR
INTERFACE
COUNTER
VOLATILE MEMORY a thru q
NON-VOLATILE MEMORY
RESET
START
STOP
MAN. FIRE FRONT
MAN. FIRE BACK

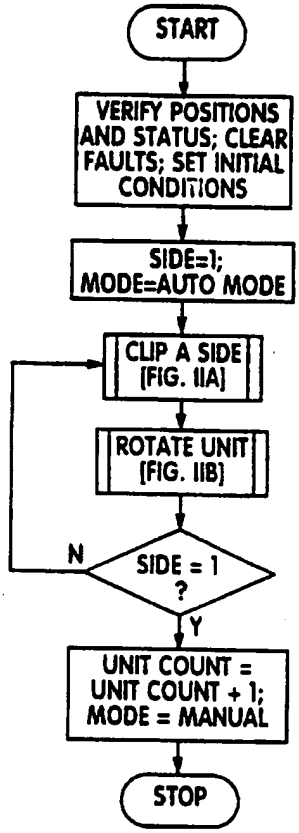

START
VERIFY POSITIONS AND STATUS; CLEAR FAULTS; SET INITIAL CONDITIONS
SIDE=1; MODE=AUTO MODE
CLIP A SIDE [FIG. IIA]
ROTATE UNIT [FIG. IIB]
SIDE = 1 ?
N
Y
UNIT COUNT = UNIT COUNT + 1; MODE = MANUAL
STOP

FIG. II

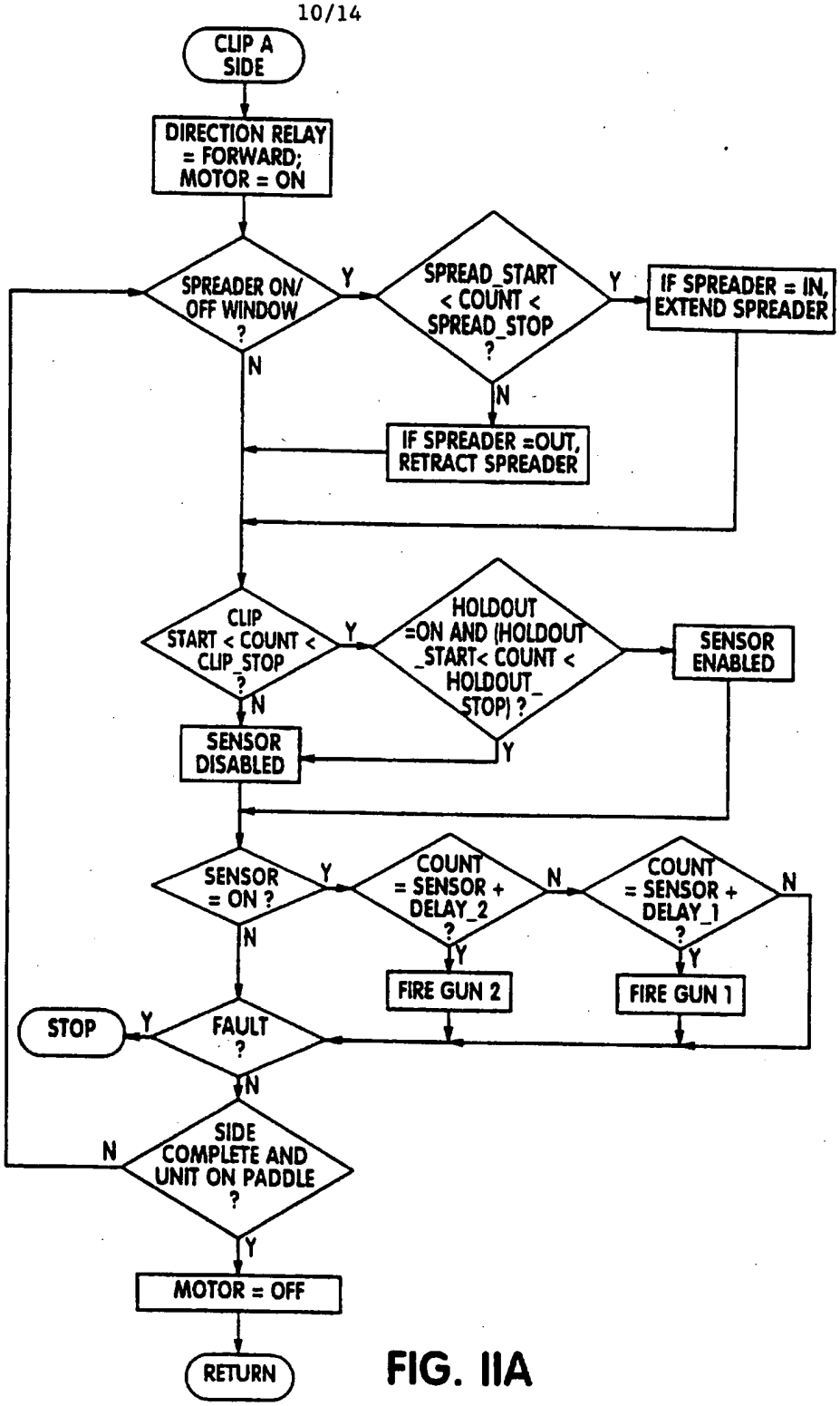

CLIP A SIDE
DIRECTION RELAY = FORWARD; MOTOR = ON
SPREADER ON/ OFF WINDOW ?
Y
SPREAD_START < COUNT < SPREAD_STOP ?
Y
IF SPREADER = IN, EXTEND SPREADER
N
N
IF SPREADER =OUT, RETRACT SPREADER
CLIP START < COUNT < CLIP_STOP ?
Y
HOLDOUT =ON AND (HOLDOUT _START< COUNT < HOLDOUT_ STOP) ?
SENSOR ENABLED
N
Y
SENSOR DISABLED
SENSOR = ON ?
Y
COUNT = SENSOR + DELAY_2 ?
N
COUNT = SENSOR + DELAY_1 ?
N
N
Y
Y
FIRE GUN 2
FIRE GUN 1
STOP
Y
FAULT ?
N
N
SIDE COMPLETE AND UNIT ON PADDLE ?
Y
MOTOR = OFF
RETURN

FIG. IIA

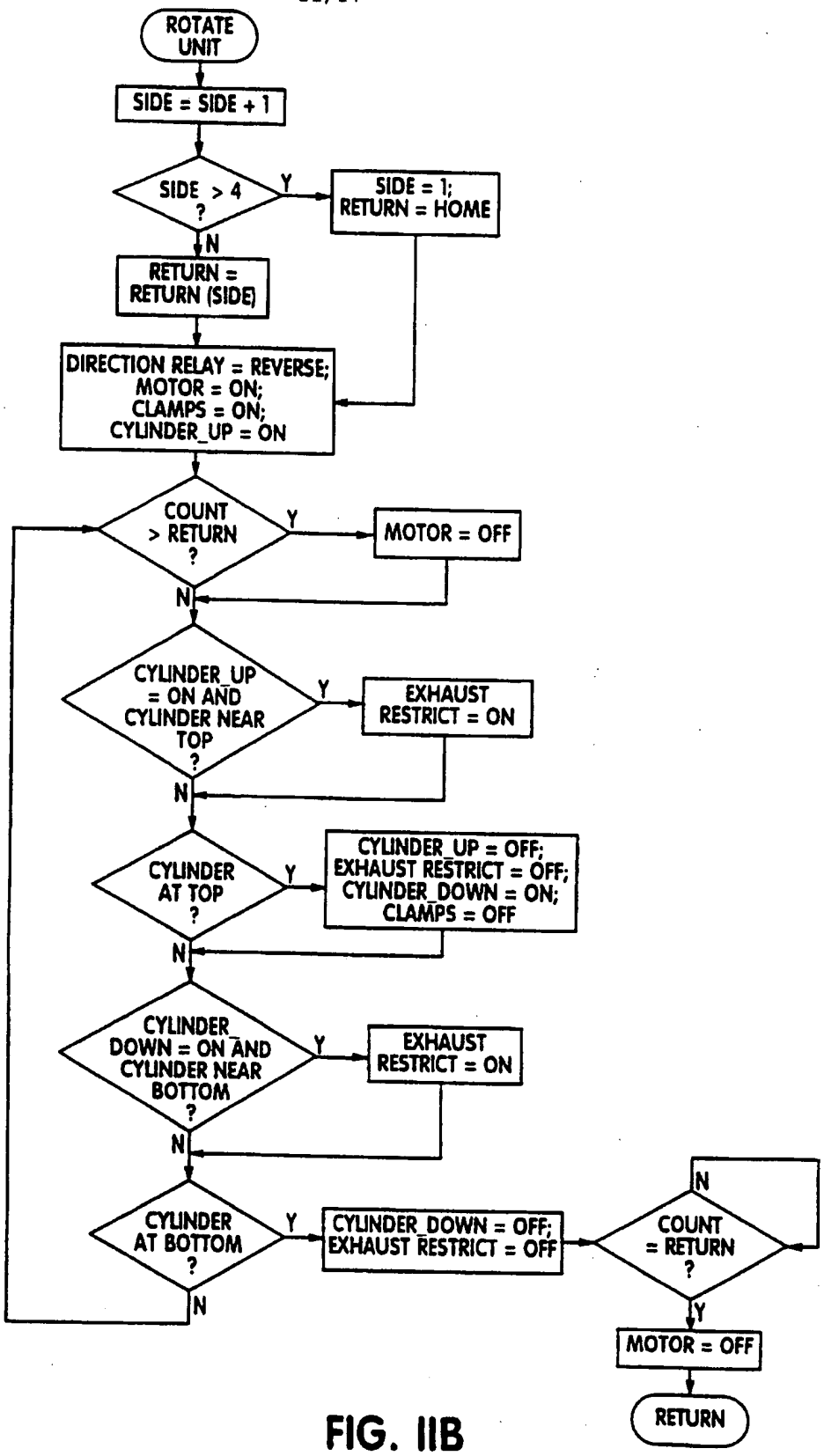

ROTATE UNIT
SIDE = SIDE + 1
SIDE > 4 ?
Y
SIDE = 1; RETURN = HOME
N
RETURN = RETURN (SIDE)
DIRECTION RELAY = REVERSE; MOTOR = ON; CLAMPS = ON; CYLINDER_UP = ON
COUNT > RETURN ?
Y
MOTOR = OFF
N
CYLINDER_UP = ON AND CYLINDER NEAR TOP ?
Y
EXHAUST RESTRICT = ON
N
CYLINDER AT TOP ?
Y
CYLINDER_UP = OFF; EXHAUST RESTRICT = OFF; CYLINDER_DOWN = ON; CLAMPS = OFF
N
CYLINDER_DOWN = ON AND CYLINDER NEAR BOTTOM ?
Y
EXHAUST RESTRICT = ON
N
CYLINDER AT BOTTOM ?
Y
CYLINDER_DOWN = OFF; EXHAUST RESTRICT = OFF
COUNT = RETURN ?
N
Y
MOTOR = OFF
RETURN
N

FIG. IIB

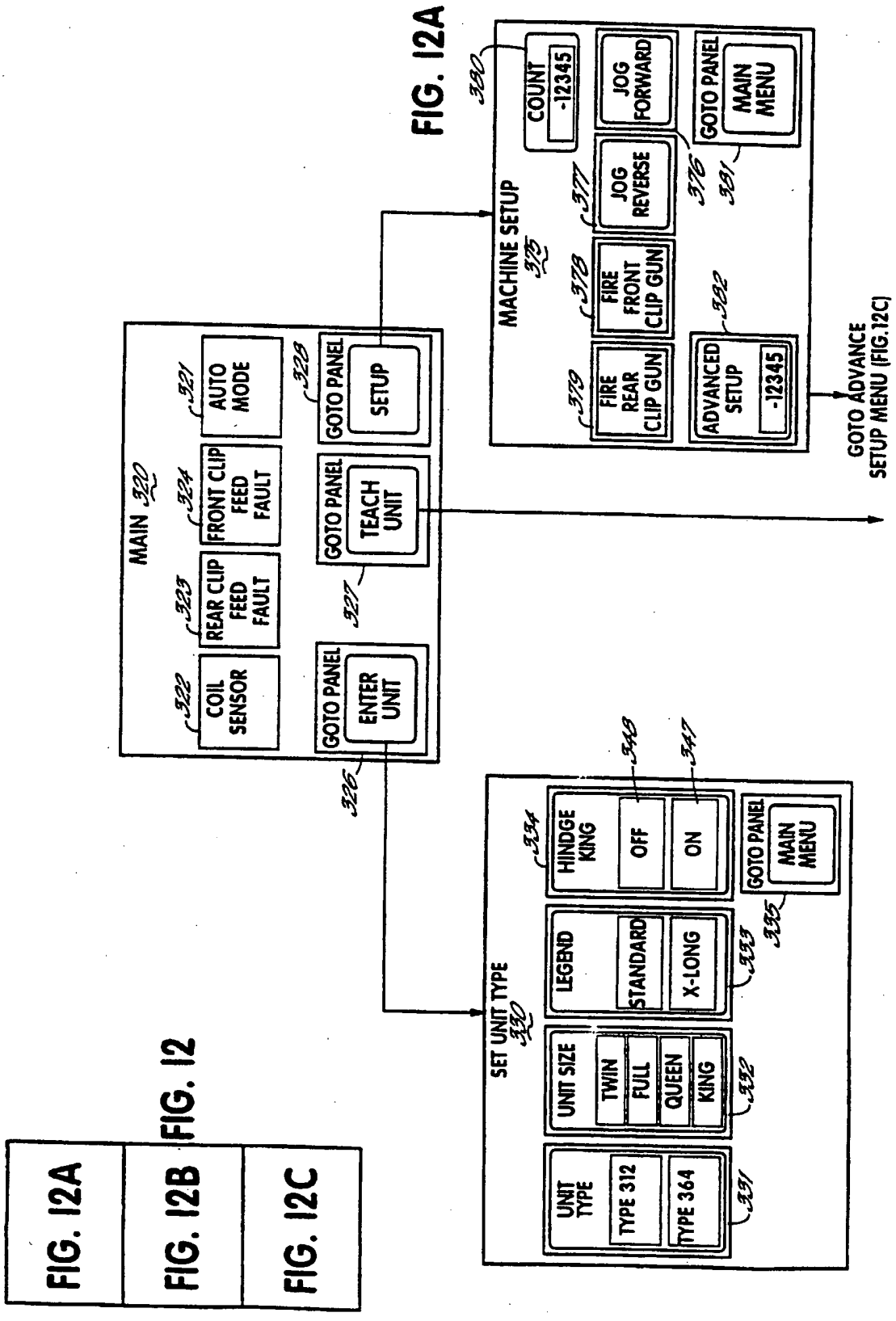


FIG. 12A

FIG. 12

FIG. 12A	
FIG. 12B	
FIG. 12C	

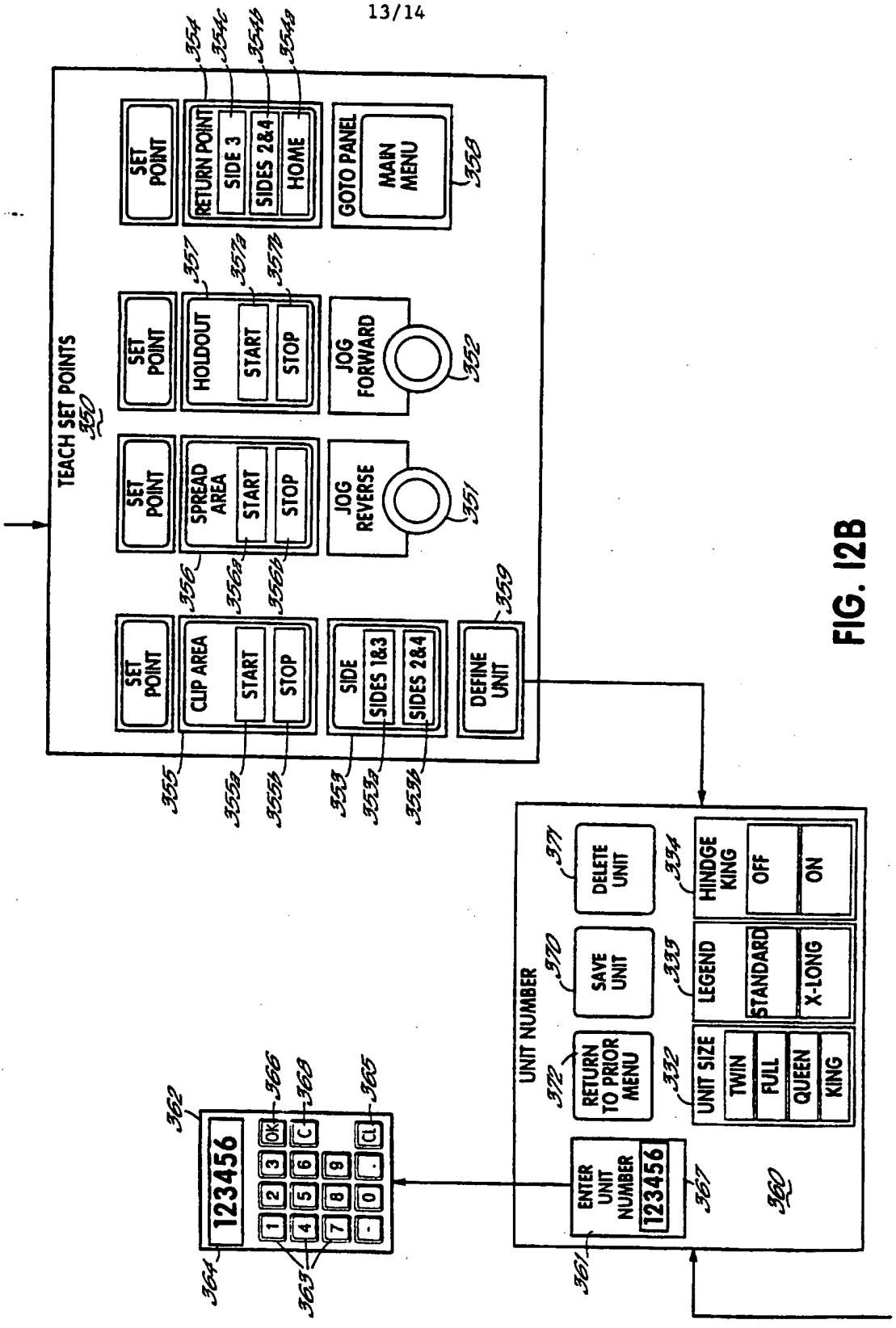
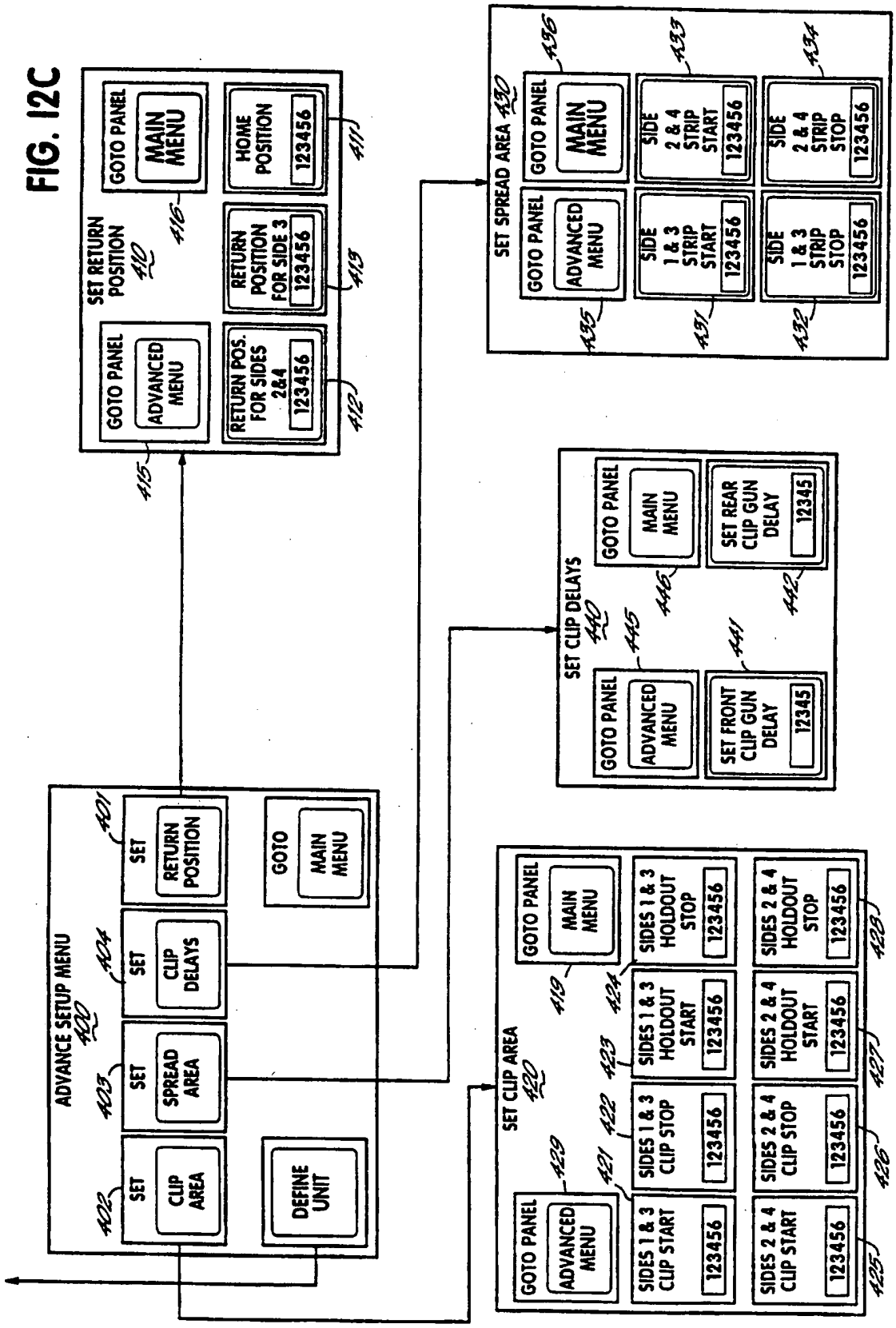

TEACH SET POINTS
SET POINT
CLIP AREA
START
STOP
SET POINT
SPREAD AREA
START
STOP
SET POINT
HOLDOUT
START
STOP
SET POINT
RETURN POINT
SIDE 3
SIDES 2&4
HOME
SIDE
SIDES 1&3
SIDES 2&4
JOG REVERSE
JOG FORWARD
GOTO PANEL
MAIN MENU
DEFINE UNIT
UNIT NUMBER
ENTER UNIT NUMBER
123456
RETURN TO PRIOR MENU
SAVE UNIT
DELETE UNIT
UNIT SIZE
TWIN
FULL
QUEEN
KING
LEGEND
STANDARD
X-LONG
HINDGE KING
OFF
ON
123456
OK
C
CL

FIG. 12B

FIG. 12C


ADVANCE SETUP MENU
400
SET CLIP AREA
402
SET SPREAD AREA
403
SET CLIP DELAYS
404
SET RETURN POSITION
401
DEFINE UNIT
GOTO MAIN MENU
SET RETURN POSITION
410
GOTO PANEL
ADVANCED MENU
415
RETURN POS. FOR SIDES 2&4
123456
412
RETURN POSITION FOR SIDE 3
123456
413
GOTO PANEL
MAIN MENU
416
HOME POSITION
123456
411
SET SPREAD AREA
430
GOTO PANEL
ADVANCED MENU
435
SIDE 1 & 3 STRIP START
123456
431
SIDE 1 & 3 STRIP STOP
123456
432
GOTO PANEL
MAIN MENU
436
SIDE 2 & 4 STRIP START
123456
433
SIDE 2 & 4 STRIP STOP
123456
434
SET CLIP DELAYS
440
GOTO PANEL
ADVANCED MENU
445
SET FRONT CLIP GUN DELAY
12345
441
GOTO PANEL
MAIN MENU
446
SET REAR CLIP GUN DELAY
12345
442
SET CLIP AREA
420
GOTO PANEL
ADVANCED MENU
429
SIDES 1 & 3 CLIP START
123456
421
SIDES 1 & 3 CLIP STOP
123456
422
SIDES 1 & 3 HOLDOUT START
123456
423
SIDES 1 & 3 HOLDOUT STOP
123456
424
GOTO PANEL
MAIN MENU
419
SIDES 2 & 4 CLIP START
123456
425
SIDES 2 & 4 CLIP STOP
123456
426
SIDES 2 & 4 HOLDOUT START
123456
427
SIDES 2 & 4 HOLDOUT STOP
123456
428

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/08741

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :B 68G 7/00; B 23P 21/00; B 23P 19/00
US CL :29/91, 407.04, 429, 525.05, 715, 720, 788, 822, 823
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 29/91, 407.04, 429, 525.05, 715, 720, 788, 822, 823

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,480,383 (YOSHIOKA ET AL.) 06 NOVEMBER 1984, SEE ENTIRE DOCUMENT	1-34
Y	US, A, 4,608,740 (BLOYS ET AL.) 02 SEPTEMBER 1986, SEE ENTIRE DOCUMENT	1-34
Y	US, A, 5,054,178 (ZUGER) 08 OCTOBER 1991, SEE ENTIRE DOCUMENT	1-34
Y	US, A, 4,553,324 (ZAPLETAL ET AL.) 19 NOVEMBER 1985, SEE ENTIRE DOCUMENT	1-34
Y	US, A, 5,497,541 (NOGUEIRA) 12 MARCH 1996, SEE ENTIRE DOCUMENT	1-34
Y	US, A, 3,789,495 (STUMPF) 05 FEBRUARY1974, SEE ENTIRE DOCUMENT	1-34

[X] Further documents are listed in the continuation of Box C. [ ] See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
21 AUGUST 1997	26 SEP 1997
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer Joseph Gorski Telephone No. (703) 308-1805

Sheila Veney
Paralegal Specialist
Group 3200

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/08741

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.